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VOL. III.
PART VI.

OCTOBER, 1903

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WAGNER FREE INSTITUTE OF SCIENCE
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CONTRIBUTIONS

TO THE

TERTIARY FAUNA OF FLORIDA

WITH ESPECIAL REFERENCE TO THE

SILEX BEDS OF TAMPA AND THE PLIOCENE BEDS OF THE CALOOSAHATCHIE RIVER

INCLUDING IN MANY CASES

A COMPLETE REVISION OF THE GENERIC GROUPS TREATED OF AND THEIR AMERICAN TERTIARY SPECIES

BY

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PART VI.

CONCLUDING THE WORK

PREFACE

AS foreshadowed in the Preface to Part V. of this Memoir, the present contribution completes the work begun in 1885. It contains the remainder of the Pelecypoda and the Brachiopoda, together with a general summary of the geological and paleontological results and a few additions and corrections to earlier parts.

As the student of these volumes will have observed (as is inevitable in such an undertaking, extending over eighteen years of labor in the field and in the laboratory), there are some modifications of the original method, some shifting of the point of view with greater knowledge of the facts, and the introduction of some improvements due to increased experience. It may be well to restate the conditions under which it was prepared, at the suggestion and with the cordial coöperation of Mr. Joseph Willcox, of the Wagner Institute.

Originally the exploitation of the Tampa silex beds, the Chesapeake Miocene, and the rich fauna of the Caloosahatchie marls was contemplated. In the field work necessary to make our collections complete within these limits other horizons were examined, and the coöperation of the United States Geological Survey through its officers, Mr. Gilbert D. Harris (now of Cornell University) and Mr. Frank Burns; of the Wagner Institute through Mr. Willcox and Mr. C. W. Johnson; of the Hon. T. H. Aldrich and Professor E. A. Smith, of Alabama, was constant and cordial. New material came in each season, until in self-defence much of it had to be put aside in order to complete the work at all.

In the earlier part of the work it was recognized that the so-called Miocene of Florida comprised two very dissimilar faunas, and to the earlier the term Old Miocene was applied in this work. Further study and material showed that this "Old Miocene" had nothing to do with the Miocene of the United States in its most typical development, as in Virginia and Maryland, but represented a group of horizons strictly analogous to those which had received from European geologists the name of Oligocene.

These horizons contained a very rich warm-water fauna which was soon found to be more or less distinctly represented in the Tertiaries of Middle America and the West Indian Islands. This fauna then had to be examined and collections made at Bowden, Jamaica, and other important points in order

that the correlation of the Antillean and continental beds might be discovered and duplication of descriptions avoided. It was found that the connection between the Atlantic and Pacific faunas ceased at about the climax of the Oligocene, and that the relations between the faunas were so intimate that the Pacific coast forms could not safely be entirely neglected. This condition of things will account for the references to faunas not strictly Floridian, of which this work contains so many, yet which were essential to the proper understanding of both the paleontological and geological evolution of the region concerned.

The accumulation of material has been so constant and so great that, if the work were to be begun now for the first time, it is probable that the number of species would be greatly increased in the gastropod groups treated of in Parts I. and II. But this sort of thing would go on forever, so great is the richness of our Tertiaries, and an attempt to include the novelties thus passed over would have prolonged indefinitely the task in hand. Enough is known to render such a course unnecessary for drawing the broad conclusions which form the most important result of these studies. For the details of these, too extensive to be properly included in a preface, the reader is referred to the general summary of results at the end of this volume. Here it may be said that, among other things accomplished, several distinct Oligocene faunas have been worked out with fulness and their relations established; a wide extension has been given to the Pliocene deposits, long confused with those of the upper Miocene; the geological relations of the beds between the Vicksburgian and the Pleistocene have been established in their main lines more clearly than has hitherto been the case in the region studied; the species of half a dozen faunas have been revised, their nomenclature modernized, many new forms recognized, described, and figured; old confusions have been cleared up, old errors rectified, and a substantial advance in the Tertiary paleontology of our southeastern coastal plain has been secured.

In a work including such a host of details it would be unreasonable to expect that the author has not occasionally erred. Nor is it to be supposed that in matters where confusion has reigned the author's judgment will prove infallible, or to the taste, in every instance, of others who may study the same data. But, with all such allowances made, it is probable that for future students (may their tribe increase) the way to an understanding of the subject has been made much easier than it was eighteen years ago.

The fact that the generally accepted Tertiary column of 1885 was really a sort of skeleton or scaffolding, in which the accepted divisions were merely the

particular horizons which accident or special conditions of preservation of the contained fossils had made conspicuous, and that numerous other beds also important stratigraphically and faunally remained to be exploited, was not then and is hardly yet appreciated.

The excellent work of Professor Harris on the Midwayan and Chickasawan divisions of the lower Eocene in his "Bulletins of American Paleontology," and the results set forth in the present work, aided by the advances in faunal knowledge of the vertebrate Tertiary faunas made by Scott, Osborne, and other energetic workers, have rendered the last ten or fifteen years more fruitful in American Tertiary geology than any period since that of Lyell.

When we remember that the successive Tertiary strata on our southeastern coastal plain are composed of nearly identical materials, one stratum being often built of the débris of those immediately preceding it; that their chemical and mineralogical constituents are necessarily practically the same; that the soft nature of the rocks, even when consolidated, lends itself to erosion and to obscuration by the subtropical luxuriant vegetation,—it would seem hardly necessary to reassert the truth so often lost sight of, that geological work which does not take careful account of the paleontological data in this region is practically futile. Nearly all the errors into which geologists have been led in this part of the country, practically all the inaccurate theorizing and incidental controversy, have arisen from ignorance of or too superficial examination of the fossil contents of these rocks. The work already done is still insufficient for any final consensus of opinion. Those beds which have afforded a well-preserved fauna are doubtless fairly well understood, that there are others like them not yet known is eminently probable, and that there are numerous others in which the removal of the fossils by solution has delayed recognition of their existence and relative importance is certain. The latter, affording only casts, or, in some fortunate cases, silicious pseudomorphs of the contained fossils, can only be intelligently studied when the intervening better-preserved faunas are thoroughly known.

Thus a rich field is open for the paleontologist, and the explorations and publications of the Wagner Institute have had exceptional importance in calling attention to the opportunities it presents. It is earnestly to be hoped that the students needed to reap the harvest will soon be forthcoming.

A certain number of the belated accessions to the collection which belong to groups which had been passed in the text before they were received were described by me in the "Proceedings of the United States National Museum," No. 1035, volume xviii., pp. 21–46, 1895. These species were not then figured,

but the illustrations of them appear now, to complete the data needed by the student, as well as figures of a few other interesting forms from similar material received too late to be utilized in the body of the work.

In the years which have elapsed since this Memoir was begun the subject of zoölogical nomenclature has been much discussed and the general consensus of opinion seems to trend towards the acceptance of names for which no diagnosis was originally supplied, provided the species cited under them are identifiable. This change from the British Association rules of 1842 is responsible for much unnecessary overturning of formerly accepted names with no visible benefit to science, but since it appears to express the will of the majority it seems useless to oppose it, and in Parts IV.–VI. it has been complied with except in the case of the anonymous auctioneer's catalogue known as the "Museum Calonnianum." This compilation from a manuscript of Hwass, edited by Da Costa, and printed for the auctioneer, George Humphrey, has usually been credited to the latter. I confess my desire to settle the nomenclature on a firm basis, though great, has not been equal to the acceptance of these anonymous, undefined, worthless names, which would involve the loss of much that is most fundamental in the nomenclature of mollusks. I still hope that the common-sense of naturalists will find a way—if necessary, an arbitrary way—to eliminate this publication from authorized sources of nomenclature. The "Museum Boltenianum" stands on a different footing, and the principal change which its acceptance involves in the earlier part of this work is the substitution of the name *Busycon* for the more familiar *Fulgur*.

Acknowledgments are due not only to the Wagner Institute of Science and its secretary, Mr. Joseph Willcox, for cordial coöperation and sympathy in the work exemplified in this Memoir, but also to the United States Geological Survey and its directors, the late Major J. W. Powell and the Hon. Charles D. Walcott, by whose permission it was carried on, and to Dr. Frank Burns and Mr. T. Wayland Vaughan, of the staff, for hearty coöperation; to the Smithsonian Institution and National Museum by the secretary and *ex officio* director, Dr. S. P. Langley, for the use of collections, library, and other facilities to an extent only limited by the needs of the occasion; to Professor W. B. Clark, director of the Maryland Geological Survey, for the loan of type specimens for comparison; to Dr. H. A. Pilsbry and other officers of the Academy of Natural Sciences for free access to the collections and other courtesies; to numerous friends and correspondents at home and abroad, among whom should especially be mentioned the Hon. T. H. Aldrich, of Birmingham, Alabama; Professor Eugene A. Smith, of Tuscaloosa, Alabama; Dr. L. T. Chamberlain, of New

York; Colonel Thomas L. Casey, United States Engineer Corps; Mr. Edgar A. Smith, of the British Museum, and M. Maurice Cossmann, of Paris.

Dr. J. C. McConnell, of Washington, D. C., who has supplied the admirable pen drawings which are reproduced in the illustrations, has been an indispensable collaborator. When the plates of this work are compared with the muddy and often wholly worthless heliotypes which disfigure so many pretentious modern paleontological publications, both the author, the Institute, and the student must feel that they are entitled to congratulate themselves on the quality of Dr. McConnell's work, which is certainly unequalled in America, if not in the world.

William Healey Dall.

Smithsonian Institution, Washington, D. C., March 31, 1903.

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TERTIARY FAUNA OF FLORIDA.

Superfamily VENERACEA (Continued).

Family VENERIDÆ.

THE most beautiful, genetically the most highly developed, and one of the most prolific in the recent faunas, this family has had a varied history and complicated elucidation.

The Linnean genus *Venus* was naturally heterogeneous, comprising animals now scattered in several distinct families. If the whole subject were to be revised here for the first time, there is no doubt the best course would be to adopt as the type of the genus Linné's first species, *Venus dione,* not only because it stands first, and was cited as an example in the "Fundamenta Testaceologica" by Linné himself and by Cuvier in his "Tableau" of 1798, but also because it was the species selected by Linné upon which he based the technical terms used in the description of the group, and it was widely known colloquially among collectors and naturalists as "the true Venus shell," and by similar appellations indicating that it was generally considered in the eighteenth century as the particular exemplar of the group. In view of the fact that Lamarck selected another form in his "Prodromus," which has been generally accepted as a type for the restricted genus, it would be unwise to attempt to reverse the course of history.

The first work in which any revision of the Linnean genus was attempted is that of Scopoli in 1777, who, following Adanson, segregated *Dosinia* and *Codakia,* but otherwise contents himself by pointing out that the group typified by *Venus meretrix* Linné has a hinge which does not fit the Linnean diagnosis of the genus.

A year earlier Da Costa, who at that time had not accepted the Linnean system of nomenclature, proposed for a group practically synonymous with *Venus* the name *Pectunculus,* including under this designation species of *Cyprina, Chione, Dosinia,* and *Arcopagia,* as appears in his "British Conchology" of 1778, in which he at last uses a consistently binomial nomenclature. In the anonymous "Museum Calonnianum," edited by Da Costa from a manu-

script of Hvass for Humphrey, the London auctioneer, the name *Pectunculus* is retained for the Linnean *Venus*. A genus *Cuneus,* for bivalves with the beaks near one end, was proposed in the "Elements" with a fossil *Trigonia* as example; in the "British Conchology" *Donax, Saxicava, Rupellaria,* etc., are included; in the "Museum Calonnianum" all the identifiable species belong to *Donax,* and it may be regarded as a synonym of *Donax* L.

Bruguière practically made no change, for though he instituted the genus *Lucina* for some of the Tellinas of Linné, the species of *Codakia,* which the latter had included in *Venus,* still remained there on the plates of the "Encyclopédie Méthodique" in 1797.

The first person to break up the Linnean genus was Bolten, whose posthumously printed catalogue of 1798 contains a host of new generic names. A study of Bolten's lists shows that it was still the external ornamentation and general form, rather than such characters as the hinge, pallial sinus, or muscular impressions, upon which he relied to discriminate his groups, but he had a keen eye and instinctively brought together species which on the whole were, by modern standards, to be regarded as akin. His groups may be described as follows:

Paphia Bolten.

Shells compressed, elongate-ovate, smooth or feebly concentrically sculptured. The group contains *Venus gigantea* Gmelin (a *Macrocallista*), *V. meroë* Gmelin (a *Sunetta*), and four species of *Tapes.*

Gafrarium Bolten.

Oblong shells with strong reticulated sculpture. It contains *Venus fimbriata* Gmelin (a *Corbis*), *V. pectinata* Gmelin (= *Crista* Roemer), and *Venus reticulata* Gmelin (a *Cytherea*).

Cytherea Bolten.

Orbicular species, which he divides into two groups: 1, flattened forms, containing *Venus granulata* Gmelin (*Timoclea*), *V. tigrina* (a *Codakia*), *V. concentrica* Born (a *Dosinia*), *Venus scripta* Gmelin (a *Circe*), *V. rugifera* Lam. (*Circe*), *Venus histrio, V. exoleta,* and *V. sinuata* Gmelin (*Dosinia*); 2, convex species, containing *Venus puerpera, rugosa,* and *verrucosa* Gmelin, and *V. juvenilis* Lam. (a *Dosinia*).

Venus Bolten.

Subtriangular species, which are divided into two groups: 1, subovate; 2, triangular, these last being also separated into smooth and sulcate subgroups.

In the first group are associated *Mercetrix chione, lusoria, morphina, maculata, erycina,* and *lilacina* of authors. In the second group, smooth section, we find *Venus islandica* (*Cyprina*); *V. tumens* Gmelin (*Pitaria*); *V. mercenaria* L.; *V. opima* Gmelin (*Tapes*); four varieties of *V. castrensis* Gmelin (*Circe*), treated as species; *V. chione* L. (*Meretrix*); *Venus tripla* and *corbicula* Gmelin (*Tivela*).

In the sulcate section of the second group are to be found *Venus dione* L.; *V. circinata* (*Meretrix*); *V. striata* Chemnitz, *V. paphia, gallina, dysera, plicata, marica,* and *donacina* Gmelin; *V. rostrata* Chemnitz (*Anomalocardia*); and *V. fluminea* Bolten (*Galatea*) = *hermaphrodita* Gmelin.

In the same year Cuvier, in the "Tableau Elémentaire de l'histoire naturelle," simply accepts the nomenclature of Bruguière, which brings us to the epoch-making "Prodrome" of Lamarck in 1799.* Lamarck systematically utilizes for the first time the valuable characters furnished by the hinge of bivalves as well as the anatomical data of Cuvier, but in the *Veneridæ* this paper merely selects a type, *V. mercenaria,* from among the forms grouped under the name of *Venus* by Bolten, segregates *Meretrix* as previously indicated by Scopoli, and uses the names *Pectunculus* and *Paphia* in a sense different from that in which either was originally proposed. In his "Systême des Animaux sans Vertèbres" two years later he discriminates the genus *Petricola* which had been included by Linné in the genus *Venus.* It may be noted here that the name *Galatea* for *Venus paradoxa* Born, which appeared in 1797 on plate ccl. of the "Encyclopédie Méthodique," is preceded by the use of the same name for a crustacean by Fabricius in 1793; the substitute *Potamophila* Sowerby, 1822, is preoccupied by Latreille for Crustacea in 1817, and the genus will have to take the name of *Egeria* Roissy, 1805. Link in 1807, following Adanson, segregated *Sunetta* and *Tivela,* but left the mass of species under *Venus.*

* As a matter of principle I have omitted consideration of works in which the Linnean binomial nomenclature was not consistently adopted and the names in which (until adopted by some binomial author from whom alone they will take date) have merely an historic interest. Such are the works of Klein, Da Costa's "Elements," Meuschen, Poli, and Duméril, as well as the worthy but pre-Linnean Adanson. Among the names sometimes found in the literature and cited from these works are *Pectunculus* Da Costa; *Chamæ formes* and *Chamæ,* Meuschen; *Callista* and *Arthemis,* Poli, 1791, with their complements, *Callistoderma* and *Arthemiderma,* Poli, 1795; and *Venusarius* Duméril.

We are now in a position to take stock of some of the Boltenian names before proceeding further. From *Paphia* Bolten, *Sunetta* and *Meretrix* have been eliminated, leaving only species of the genus ordinarily called *Tapes* (Mühlfeld, 1811), which must retain Bolten's name.

From *Cytherea* Bolten the subtraction of *Codakia* and *Dosinia* leaves only species of the type of *V. puerpera* and *granulata* Gmelin and *scripta* Gmelin.

From *Venus* Bolten the subtraction of *Venus* (typical), *Meretrix, Tapes* (sp.), *Tivela,* and *Egeria* or *Galatea* leaves only species of the type of *V. islandica, tumens, castrensis, dione,* and *rostrata.*

In Megerle von Mühlfeld's "Essay at a New System of Conchology," 1811, a number of new names appear: *Cuneus* Megerle, based on *Venus meroë* L., is a synonym of *Sunetta* Link; *Tapes* Megerle is the equivalent of (the eliminated) *Paphia* Bolten; *Chione* Megerle includes such forms as *V. cancellata* and *V. gallina; Fimbria* Megerle (a preoccupied name) was afterwards named *Corbis* by Cuvier; *Trigona* Megerle, preoccupied in insects, is *Tivela* Link; *Orbiculus* Megerle is a compound of *Dosinia* and *Codakia* Scopoli.

Lamarck seems to have repented of using the somewhat indelicate name of *Meretrix,* and in 1805 Roissy cites a genus *Citherea* "Lamarck" which is the equivalent of *Meretrix.* In the "Annals du Museum" (vii., p. 132) Lamarck definitely substitutes the name *Cytherea* for *Meretrix,* which was afterwards very generally dropped in favor of the new name. The *Cytherea* of Lamarck, however, is not *Cytherea* Bolten, the latter having priority over the former as well as over *Meretrix.*

The next most important advance was made by Schumacher,* though a number of the groups he segregated had been previously named. *Anomalocardia* Schumacher was proposed for a group of *Veneridæ* typified by *V. fluctuosa* L.; *Mercenaria* for the typical *Venus* Lamarck, 1799; *Tapes* Megerle is adopted; *Arctica* is proposed for *Venus islandica* (L.) Müller; *Tridonta* for the group which had the year before been named *Astarte* by Sowerby, and was to be named *Crassina* by Lamarck after Leach in the year following; *Lentillaria* for *Codakia* Scopoli; *Meroë* for *Sunetta* Link; *Cytherea* Lamarck is adopted and *Venus,* for which *V. dione, V. circinata,* and *Dosinia exoleta* are cited as examples. The genus *Circe* is proposed for *Venus scripta* L.; *Trigona* is used for Link's *Tivela; Antigona* for a new species allied to *Cytherea* Bolten; *Idothea,* a name preoccupied in Crustacea, is given to Megerle's *Fimbria.*

Schumacher's names reduce *Cytherea* Bolten to *Veneridæ* of the type of

* Essai d'un Nouveau Système des habitations des vers testacés, Copenhagen, 1817.

Venus puerpera, for which it must be retained. They also clear up the unappropriated residue of *Venus* Bolten, except *V. tumens* and *V. dione.*

Gafrarium Bolten is by this time relieved of the genus *Corbis* and retains only *V. reticulata* L. and the Circes of the group later called *Crista* by Römer. *V. reticulata* belongs to *Cytherea* Bolten. There is no essential change in the "Animaux sans Vertèbres" of Lamarck in 1818. In 1838 Gray, in the "Analyst," * contributes a Catalogue of *Cytherea* (Lamarck, not Bolten), in which he proposes a genus *Chione* which is not *Chione* Megerle, but has a small anterior lateral tooth and was based on *Venus chione* L. A genus *Dosina,* based on *Venus verrucosa* L., is identical with the *Cytherea* of Bolten as eliminated.

Early in the century Dr. William Elford Leach, of the British Museum, was active in systematic biology and coined a large number of generic names which appeared on labels of the Museum and were used in his correspondence and quoted in synonymy by Lamarck, Risso, Brown, Gray, and other pupils or contemporaries. These names were frequently changed by him, many of them were never properly described, and even after his death Dr. Gray published a work of Leach which, without adding much to knowledge or exhibiting any very marked dependence on the anatomical characters of the Mollusks for guidance, increased very largely the number of synonyms and uncertain designations of the British Mollusca. A number of names were proposed by Captain Thomas Brown in his "Illustrations of Conchology" in 1827, part of which were derived from Leach, and none of which were defined. Others appear in Gray's very helpful but not always reliable "List of Genera of Recent Mollusca" in 1847, in his "List of British Animals" (Mollusca) in 1851, and in his "Arrangement of the Figures" in Mrs. Gray's "Figures of Molluscous Animals," vol. v., 1857.

Among important publications for the nomenclature of the *Veneridæ* in the nineteenth century is the arrangement of Mörch in the second part of his "Catalogue of the Yoldi Collection," 1853, where many non-binomial names of Klein and others are for the first time employed in binomial nomenclature, though without definitions or citation of especial type species. About the same time, in the British Museum duodecimo series of publications, Deshayes published a "Catalogue of the Conchifera, Part I.," including the *Veneridæ.* Though the laws of nomenclature were not adhered to with any strictness, and some of the names therefore cannot stand, this marked a considerable advance on previous literature of the subject. In 1857 Eduard Römer printed as an inaugural dis-

* Vol. viii., No. xxiv., pp. 302–9, London, 1838.

sertation for the doctorate of philosophy a "Kritische Untersuchung" of the Linnean genus *Venus,* in which a systematic arrangement of the species was proposed which has had a strong influence on subsequent literature of the subject. Unfortunately, Römer's ideas of nomenclature were rather bizarre; he divided his subgenera into "families," and proposed new names to cover groups composed of genera of older date which he reduced in rank. Though his paper contained a vast amount of information, his disregard of the rules and ignorance of certain works bearing on the nomenclature of the group render his arrangement more or less defective. Later this author prepared a number of monographs of groups of *Veneridæ,* with very beautiful and accurate plates, which will permanently associate his name with the study of this attractive group of Mollusks.

The reviews of the genera in Stoliczka's "Cretaceous Pelecypoda of India," 1871, and Fischer's painstaking "Manuel de Conchyliologie," 1887, must be consulted by all students of the *Veneridæ.* A revision by the writer, covering the family *Veneridæ,* was published in the "Proceedings of the U. S. Nat. Museum," xxvi., No. 1312, pp. 345–366, 1902.

This family is here divided into four subfamilies, *Dosiniinæ, Meretricinæ, Venerinæ,* and *Gemminæ.*

Subfamily DOSINIINÆ.

This group is composed chiefly of orbicular shells with concentric sculpture, which have a large arcuate foot and long, closely united siphons. The hinge, except in *Clementia,* which is somewhat degenerate and has the hinge much reduced in relative size, has three left and four right cardinals. There are usually no posterior laterals, and the anterior laterals, when present, are usually practically obsolete.

The group recedes in time to the Eocene and has never been very abundant in species. A number of species have been described from the Cretaceous and even from the Jurassic, but, as Stoliczka has pointed out, these are mostly not true Dosinias, but belong to *Cyprimeria* and other groups which are precursors of the *Veneridæ.*

The earlier representatives of the subfamily have a corrugated area on the adjacent surfaces of the nymphs and posterior lateral teeth, and it is interesting to note that in the nepionic young of *Dosinidia,* sometimes even up to a size of ten millimetres, this corrugation is retained, though, as the shell grows, it becomes obscure and finally disappears. As in many shells with broad

nymphs and strong ligament, a carious process goes on below the beaks, resulting in the decay of the shelly matter and the formation of a small cavity under the anterior end of the ligament which sometimes encroaches on the posterior cardinals. This has been mistaken by some writers for a normal formation, but is merely the result of decay due to the access of seawater and senility of the adjacent portion of the ligament.

A. *Anterior and posterior laterals present, the lunule impressed but not definitely limited.*

Genus **DOSINIOPSIS** Conrad.

Dosiniopsis Conrad, Proc. Acad. Nat. Sci. Phila. for 1864, p. 213 (*D. Meekii* Conrad, *loc. cit.*); Meek, Pal. Upper Missouri, p. 179, 1876; Tryon, Str. and Syst. Conch., p. 178, 1884; Fischer, Man. de Conchyl., p. 1079, 1887.

Cytherea Stoliczka, Cret. Pel. India, p. 151, 1879.

The type of this remarkable group is *Cytherea lenticularis* Rogers, Trans. Am. Phil. Soc., vi., p. 372, pl. xxviii., fig. 1, 1839, a more solid and heavy variety of which was named by Conrad *D. Meekii.**

It is an orbicular shell, with a dark and heavy periostracum, which is frequently well preserved in the fossils, covering a concentrically striated surface. The inner margins are smooth, the pallial sinus is short, free, acutely angular, and ascending. The lunule is impressed but not distinctly circumscribed, and there is no defined escutcheon, though the area in which the ligament is seated is depressed below the hardly carinated dorsal margins. The hinge is strong and remarkable in being the only genus of the family in which there is a distinctly developed posterior lateral tooth. This enters an excavated socket in the left valve which is not bounded by any laminæ. The nymphs are corrugated and there is a strong corrugated left anterior lateral. The posterior right cardinal is broad and deeply channelled above. If Stoliczka had seen the typical species he would not have referred the group to *Cytherea* Lamarck. The dental formula is $\frac{\text{L. } 0.\text{x}101010.010}{\text{R. } 1.\text{x}010101.101}$. The genus, so far, is only known positively from the Eocene of France and eastern North America; the two British species, *Venus plana* and *Cyprina planata* of Sowerby, referred to *Dosiniopsis* by Mr. Conrad in 1866, appear from the figures to be respectively a *Meretrix* and a

* See Clark, U. S. Geol. Survey, Bull. 141, p. 78, pl. xviii., figs. 1a–1g, 1896.

Cyprina, while the Californian form, *D. alta,* is still too little known for exact determination.

Except in the number of cardinals and the presence of a sinus *Dosiniopsis* is conchologically a *Cyprina,* but the above characters indicate its proper place to be in this family.

Subgenus AEORA Conrad.

Æora Conrad, Am. Journ. Conch., vi., p. 72, 1870 (type *Æora cretacea* Conrad, Cretaceous of New Jersey); Whitfield, Brach. Lam. Raritan Clays, p. 168, pl. xxiii., figs. 16, 17, 1885.

This species and genus is still known only by Conrad's type. So far as I am able to discover, it does not differ in its characters from *Dosiniopsis,* except as a smaller, more delicate, and more elongated shell might differ from a heavy and orbicular one. The presence or absence of the right posterior lateral is not yet determined, but the excavation of the left hinge-plate leads to the probability that there is a tooth to occupy it. Professor Whitfield was mistaken in supposing that Stoliczka referred this group to the *Tellinidæ.* In reality, he placed it next to *Thetironia* among the precursors of the *Veneridæ.*

Subgenus PELECYORA Dall, 1902.

Type *Cytherea hatchetigbeënsis* Aldrich, from the upper Chickasawan Eocene of Hatchetigbee Bluff, Alabama. See Harris, Bull. Am. Paleont., ii., pl. xviii., figs. 11, 12.

Shell orbicular, with rugose nymphs, simple anterior lateral and socket; no posterior lateral; the pallial sinus narrow, angular, ascending, rather long; otherwise as in *Dosiniopsis.* The right posterior cardinal is bifid, the others entire.

This group differs from *Dosiniopsis* in its smooth lateral and socket, absence of the posterior lateral, and relatively deeper pallial sinus. The same characters, as well as its orbicular form and entire left cardinals, distinguish it from *Æora* as described.

B. *An anterior left lateral tooth present, the lunule distinctly limited by an incised line.*

Genus DOSINIA Scopoli.

Dosinia Scopoli, Introd. ad Hist. Nat., p. 399, 1777. Type Le Dosin Adanson, = *Dosinia africana* Hanley.

Cytherea (sp.) Bolten, Mus. Boltenianum, p. 177, 1798; ed. ii., p. 124, 1819; Lamarck,

An. s. Vert., v., pp. 572, 573, 1818; Turton, Dithyra Brit., p. 162, 1822; Menke, Synop. Meth. Moll., p. 116, 1830; Macgillivray, Moll. Scotl., p. 212, 1844.

Orbiculus β (sp.) Megerle, Entw. Neuen Syst. der Schälth., Mag. d. Ges. Naturf. Freunde, p. 58, 1811; *Venus exoleta* L. (not *Orbicula* Cuvier, 1798).

Arthemis Oken, Lehrb. d. Naturg., p. 229, 1815, after Poli, 1791; (*Venus exolcta* L.) Blainville, Man. Mal., p. 556, 1825; Deshayes, An. s. Vert., ed. ii., vi., p. 295, 1835; Philippi, Abbild. u. Beschr., i., p. 171, 1844.

Artemis Conrad, Fos. Tert. Form., p. 20, 1832; Anton. Verz., p. 6, 1839; Sowerby, Conch. Man., ed. ii., p. 78, 1842; Nyst. Coq. foss. Belgique, p. 183, 1846 (not of Mulsant, 1851).

Asa Defrance (after Leach MS.) in Basterot, Mém. géol. env. de Bordeaux, p. 90, 1825; Gray, Ann. Mag. N. Hist., xx., p. 272, 1847.

Aretoë Risso, Eur. Mérid., iv., p. 361, 1826, *Venus exoleta* L.

Exoleta Brown, Ill. Conch. Gt. Brit., pl. xx., figs. 2, 3, 1827 (*V. exoleta* L.); Zool. Textb., i., p. 450, 1833; Conch. Textb., ed. iv., p. 127, 1839.

Arctoa Herrmannsen, Ind. Gen. Mal., i., p. 76, 1846.

Cerana Gistel, Naturg. Thierr., p. viii., 1848; *Venus exoleta* L.

Assa (Leach MS.) Gray, List. Brit. An. Brit. Mus., p. 3, 1851.

Amphithœa Leach, Syn. Brit. Moll., p. 312, 1852.

Arthemis Gray, Analyst, viii., No. xxiv., p. 308, 1838.

Dosinia Deshayes, Cat. Conch. Brit. Mus., p. 5, 1853; Römer, Mon. *Dosinia*, p. 7, 1862; H. and A. Adams, Gen. Rec. Moll., ii., p. 430, 1857; Tryon, Str. Syst. Conch., ii., p. 180, 1884; Fischer, Man. de Conchyl., p. 1082, 1887; Dall, Bull. 37, U. S. Nat. Mus., p. 56, 1889.

Not *Dosina* Gray, Analyst, viii., No. xxiv., p. 308, 1838; P. Z. S., 1847, p. 183, No. 542; *Venus verrucosa* L.

Animal with a large arcuate foot and closely united siphons. Complete dental formula (the posterior right cardinal, being extremely thin, is often broken off, eroded, or obsolete) $\frac{\text{L. } 0101010.010}{\text{R. } 1010101.101}$. The thick middle cardinals are often bifid or excavated. Valves suborbicular, generally compressed, with a long and strong ligament seated in a groove and enfolding a heavy resilium; lunule small, impressed; escutcheon narrow, nearly linear or absent; hinge-plate broad and thick; valve-margins smooth; pallial sinus rather long and usually acute, anterior lateral teeth nearly obsolete and usually simple; sculpture usually of elegantly concentric grooves and interspaces, sometimes raised into lamellæ at the borders of the lunule and escutcheon, crossed rarely with weak radial threads; coloration of the recent species rarely disposed in patterns and usually pale, many species being white. The periostracum is usually thin and polished. The group may be divided into sections as follows:

Section *Dosinia* s. s. Type *Le Dosin,* Adanson, = *Dosinia africana* Hanley. Senegal.

Lunule small, impressed; escutcheon narrow elongate, flattish, bordered on each side by a ridge or keel at which the concentric sculpture tends to become lamellose; lateral tooth small, smooth; pallial sinus angular, ascending, usually narrow and elongated; valves moderately convex.

The escutcheon may be merely a flattening of the posterior dorsal border, often unequal in the two valves, or it may be a well-defined area bordered by distinct keel, more or less lamellose where the concentric sculpture intersects the carina. Between these types almost continuous gradation may be traced.

Section *Orbiculus* Megerle, 1811. Type *Venus exoleta* Linné.

In this section there is no escutcheon, the pallial sinus is very long and narrow and the anterior lateral is smooth and strong; otherwise it agrees with *Dosinia* s. s. *Arthemis* (*Poli*) Oken, *Artemis* Conrad, *Arctoë* Risso, *Arctoa* Hermannsen, and *Cerana* Gistel are synonyms. *Orbiculus* α of Megerle is a typical *Dosinia,* and the second species of *Orbiculus* β was a *Codakia.* The posterior cardinals in the young are not corrugated.

Section *Austrodosinia* Dall, 1902. Type *Cytherea anus* Philippi. New Zealand.

Lunule deeply impressed; escutcheon impressed and bordered by prominent keels; pallial sinus short and angular; anterior cardinals and especially the anterior lateral with the pit into which it is received sharply corrugated. This group is also represented in Japan.

Section *Dosinella* Dall, 1902. Type *Cytherea angulosa* Philippi. East Indies.

Valves suborbicular, with a shallow, flattish lunule; the escutcheon narrow, flattish, hardly defined; pallial sinus deep, ample, ascending, bluntly rounded at the anterior end; anterior lateral and posterior right cardinal teeth absent or obsolete.

There are a few small species, such as *D. hepatica* Philippi, which have the bight of the pallial sinus rounded instead of angular, but in this large form the discrepancy is so marked, that, in connection with the obsolescence of the teeth, it seems that a sectional separation is warranted.

Section *Dosinorbis* Dall, 1902. Type *Arthemis bilunulata* Gray. Japan.

Lunule and escutcheon deeply impressed, the former small, set in a large impressed area which, like the escutcheon, is bordered by a lamellated keel; valves compressed, beaks produced; the sculpture of the middle of the disk

obsolete, becoming lamellar laterally; pallial sinus short, angular, horizontally directed; lateral tooth smooth, feeble; middle left and two posterior right cardinals bifid; right posterior margin beyond the hinge-plate grooved to receive the edge of the opposite valve.

In the young the edges of the valves adjacent to the ligament pout more or less obviously, a character lost or obscure in the adult.

Section *Dosinisca* Dall, 1902. Type *Artemis alata* Reeve.

Areas of the lunule and escutcheon pouting mesially, defined by a pronounced sulcus, forming a posterior wing which recalls *Phacoides;* sculpture of fine, rather distant, sharp lamellæ, sometimes with radial striation; valves thin; pallial sinus deep and angular; lateral tooth entire.

This group is distributed in Australia and Japan.

Section *Dosinidia* Dall, 1902. Type *Venus concentrica* Born. America.

Valves suborbicular, more or less compressed, white, with a sculpture of concentric grooving, the interspaces never lamellose; furnished with an obvious periostracum; lunule small, impressed; escutcheon absent; pallial sinus ample, ascending, angular in front; middle cardinals broad, sulcate or bifid, anterior lateral small, feeble, smooth.

This group is confined to the tropical and warmer temperate waters of America, where it replaces all the other sections of the genus. The nepionic young have the posterior cardinals corrugated and there are obscure traces of a posterior lateral, but these characteristics are soon lost and leave no traces in the adult.

Dosinia (Dosinidia) chipolana n. sp.

Plate 54, Figure 4.

Oligocene of the Chipola horizon on the Chipola River, Calhoun County, Florida, at Alum Bluff and the silex beds at Ballast Point, Tampa Bay.

Shell rather small and thin, suborbicular, moderately convex, with full, pointed beaks, with fine, sharp concentric grooves having the distal side more abrupt, the interspaces flattish and hardly raised towards the ends of the shell; lunule lanceolate, impressed; beaks sculptured like the rest of the shell; anterior dorsal margin convexly arched; hinge-plate rather short and wide; teeth normal; the adductor scars large; the pallial sinus ample, ascending, acute in front, terminating two-thirds the distance forward from the posterior to the anterior adductor. Height 37.5, length 40.0, diameter 17.0 mm.

The nepionic young of this species have very much the form of the adult and are usually sculptured in much the same way.

Dosinia (Dosinidia) liogona n. sp.

PLATE 53, FIGURES 4, 7; PLATE 54, FIGURE 11.

Uppermost Oligocene at Oak Grove, Santa Rosa County, Florida; Burns.

Shell much resembling the last, from which it differs by the less convex posterior dorsal margin; smooth or feebly sculptured beaks, sculpture rising into a sharp, fine lamellæ towards the ends of the shell, smaller adductor scars, narrower hinge-plate, and different form of the nepionic young. Height 45, length 48, diameter 18 mm.

The young shells are proportionately more elevated and shorter than the adult and most of them are smooth or very sparsely concentrically grooved. At first sight they would hardly be recognized as the same as the adults. The posterior cardinals are elegantly crenate. In the adult the anterior left and posterior right cardinals are grooved on the distal edge.

Dosinia (Dosinidia) acetabulum Conrad.

Artemis acetabulum Conrad, Fos. Tert. Form., p. 20, pl. vi., fig. 1, 1832; Fos. Medial Tert., p. 29, pl. xvi., fig. 1, 1838.

Cytherea obovata Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 132, 1834 (young shell); Fos. Medial Tert., p. 14, pl. viii., fig. 4, 1838.

Dosinia acetabulum Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 10, 1864; Whitfield, Mio. Moll. N. J., p. 73, pl. xiii., fig. 2, 1895.

Dione obovata Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863 (young shell); Meek, Mio. Checkl., p. 9, 1864.

Dosinia obovata Conrad, Am. Journ. Conch., vi., p. 77, 1870 (young shell); not of Bush, Trans. Conn. Acad. Sci., vi., p. 477, 1885 (= young of *D. elegans* Conrad).

Miocene of New Jersey (artesian boring at Atlantic City); of Maryland, at St. Mary's River (type locality), one mile north of Greensboro', near the Choptank River, Calvert County, Plum Point, and Jones Wharf on the Patuxent River; of Virginia, at Grove Wharf and also near Smithfield on the James River; Coggins Point; three miles above Yorktown, on the York River; Petersburg; and in various places near Suffolk on the Nansemond, and in the marl below the peat of the Great Dismal Swamp; of Florida, in the Chesapeake Miocene horizon at Alum Bluff on the Chattahoochee River (variety *obliqua*).

This large species, which Conrad at one time seems to have confounded with the recent *D. concentrica* Born, of the Florida Keys, has two mutations which are more or less connected by intermediate forms. The typical form is somewhat transversely suborbicular and convex with the sculpture tending to obsolescence on the middle of the disk. It is shown by very perfect topotypes to have had in life a dark brown periostracum, very rarely preserved.

The other extreme, which may be called variety *obliqua* (pl. liv., fig. 13), is more compressed and higher, with the basal margin obliquely produced. It is found with the others, and though at first I supposed it to be a distinct species, I have been obliged to give up that idea. The nepionic young, less than ten millimetres in height, from Suffolk, Virginia, were described by Conrad as a species of *Cytherea*. They are often proportionately higher than the adults and show the evanescent corrugations of the posterior cardinal teeth, which recall its relations to *Dosiniopsis* of the Eocene.

Dosinia (Dosinidia) elegans Conrad.

Artemis elegans Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 325, 1843; Am. Journ. Sci., 2d Ser., ii., p. 393, 1846.

Artemis concentrica Reeve, Conch. Icon., vi., pl. ii., fig. 1, 1850; not of Born, 1780.

Dosinia concentrica Tuomey and Holmes, Pleioc. Fos. S. Car., p. 82, pl. xxi., fig. 7, 1855.

Dosinia elegans Deshayes, Cat. Conch. Brit. Mus., p. 29, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 431, 1857; Dall, Bull. 37, U. S. Nat. Mus., p. 56, 1889.

Artemis transversus Emmons, Geol. Rep. N. Car., p. 295, figs. 223, 224, 1858.

Dosinia intermedia Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863; Meek, Checkl. Mio. Fos., p. 10, 1864.

Pectunculus albidus, etc., Lister, pl. cclxxxviii., fig. 124, 1685.

Upper Miocene of the Chesapeake horizon at Alum Bluff, Florida, and of the Sumter district, South Carolina; Pliocene of Florida, in the Caloosahatchie beds on the Caloosahatchie River, at Shell Creek and Alligator Creek; Pleistocene of North Creek, near Osprey, Florida; Dall. Living in the warm water off Cape Hatteras, North Carolina; Charleston, South Carolina; west mouth of the St. John's River, East Florida (Britt); West Florida, Tortugas, Texas and southward to Yucatan and St. Thomas.

This fine, flat, and evenly concentrically sculptured species is one of those long confused under the name of *concentrica,* but it is not the *Venus concentrica* of Born. Misled by the confusion, I referred the species collected at Porto Rico to this name, but the specimens really belong to *D. concentrica,* as subsequent study has shown me. The Pliocene form described by Tuomey

and Holmes under the name of *Dosinia concentrica* is not the same as the Pleistocene one later identified with it by Holmes. The latter is *Dosinia discus* Reeve. The young were referred to *Dosinia obovata* Conrad by Miss Bush in 1885, but *D. obovata* is the young of *D. acetabulum* Conrad.

Dosinia (Dosinidia) discus Reeve.

Artemis concentrica Conrad, Am. Marine Conch., p. 55, pl. xii., 1831; Philippi, Abb. und Beschr., ii., p. 171, 1844; Conrad, Am. Journ. Sci., 2d Ser., ii., p. 393, 1846. (Not *Venus concentrica* Born.)

Cytherea concentrica De Kay, Zool. N. Y., v., p. 216, 1843.

Dosinia concentrica Holmes, Post-Pl. Fos. S. Car., p. 37, pl. vii., fig. 4, 1860.

Artemis discus Reeve, Conch. Icon., vi., pl. ii., fig. 9, 1850; Conrad, Proc. Acad. Nat. Sci. Phila., vi., p. 320, 1853; Sowerby, Thes. Conch., ii., p. 657, pl. cxl., fig. 9, 1852.

Dosinia discus Deshayes, Cat. Conch. Brit. Mus., p. 10, 1853; Conrad, Proc. Acad. Nat. Sci. Phila., vii., p. 30, 1854; Tryon, Am. Marine Conch., p. 161, pl. xxx., fig. 399, 1873; Dall, Bull. 37, U. S. Nat. Mus., p. 56, 1889.

Pliocene of the Brunswick Canal, Georgia, J. H. Couper; of the Caloosahatchie beds on the Myakka and Caloosahatchie Rivers and Shell Creek, Florida; Pleistocene of South Carolina at Simmons Bluff. Living from Cape May, New Jersey, to Vera Cruz, Mexico, but not authentically identified from any of the Antillean Isands.

This is the most compressed of our east coast species and is characterized by finer and closer concentric striation and a notably darker coloration of the yellowish-brown periostracum, which is generally shaded in darker and lighter zones.

Dosinia (Dosinidia) concentrica Born.

Venus concentrica (*ex parte*) Gmelin, Syst. Nat., p. 3286, 1792; Chemnitz, Conch. Cab., vii., p. 10, 1784.

Venus concentrica Born, Mus. Vindob., p. 71, pl. v., fig. 5, 1780.

Venus dilatata Solander, Mus. Calonnianum, p. 48, No. 905, 1797.

Cytherea (*Arthemis*) *patagonica* Philippi, Abb. und Beschr., i., p. 169, pl. ii., fig. 1, 1844.

Venus Philippi Orbigny, Voy. Am. Mér., p. 553, 1847.

Artemis patagonica Reeve, Conch. Icon., vi., pl. vii., fig. 40, 1850; Sowerby, Thes. Conch., ii., p. 657, pl. cxl., fig. 8, 1852.

Artemis concentrica Sowerby, Thes. Conch., ii., p. 655, pl. cxl., fig. 1, 1852.

?Artemis nitens Reeve, Conch. Icon., *Artemis*, pl. iii., fig. 12, 1850.

?Artemis distans Sowerby, Thes. Conch., ii., p. 655, pl. cxl., fig. 3, 1852.

Dosinia concentrica H. and A. Adams, Gen. Rec. Moll., ii., p. 431, 1857.

Dosinia floridana Conrad, Am. Journ. Conch., ii., p. 280, pl. xv., fig. 4, 1866.
Dosinia elegans Dall, Rep. Moll. Porto Rico, p. 486, 1901, not of Born.

Pleistocene of Cuba, Orbigny; living in the Florida Keys (Conrad), Martinique, Porto Rico, Aspinwall, or Colon, and southward to Rio de Janeiro.

The early writers, misled by the similarity of the species, confounded under the name *concentrica* a number of Dosinias. The first to give an original figure upon which the name may depend was Born, who gave an erroneous synonymy but an excellent figure of the present shell. Orbigny, later, discriminated between *D. elegans* Conrad (Lister, pl. cclxxxviii., fig. 124) and *D. concentrica,* but, regarding *elegans* as the original *concentrica,* gave a new name to the shell which Philippi erroneously ascribed to Patagonia, but which agrees with Born's figure, which *elegans* does not.

The confusion between the species has been so general that it is unsafe to cite habitats from the literature, but we have it from Colon, on the Isthmus of Darien, and an immature specimen is said by Conrad to have come from the Florida Keys, and was named by him *D. floridana.* It is somewhat smaller than *D. elegans,* more convex, and the sculpture is less persistent on the middle and base of the shell, while the lunule is much larger.

Dosinia (Dosinidia) ponderosa Gray.

Artemis ponderosa Gray, Analyst, viii., p. 309, 1838; Reeve, Conch. Iconica, *Artemis,* pl. i., fig. 4, 1850; Hanley, Descr. Cat. Rec. Sh., p. 109, pl. xix., fig. 38, 1843; Sowerby, Thes. Conch., ii., p. 656, pl. cxl., fig. 2, 1852.
?Artemis distans Sowerby, Thes. Conch., ii., p. 655, pl. cxl., fig. 3, 1852 (young shell).
Cytherea (Artemis) gigantea (Sowerby MS.) Philippi, Abb. Beschr. n. Conchyl., p. 33, pl. vi., fig. 1, 1847.
Venus cycloides Orbigny, Voy. Am. Mérid., p. 562, 1847; B. M. Cat. Orb. Moll., p. 67, No. 596.
Dosinia ponderosa Deshayes, Cat. Conch. Brit. Mus., p. 7, 1853; Carpenter, Maz. Cat., p. 60, 1857.

Pleistocene of San Diego and San Pedro, California, Hemphill; living from San Ignacio lagoon, west coast of Lower California, to Payta, Peru.

This is the finest species of the genus, unless the *D. grandis* Nelson (Trans. Conn. Acad. Sci., ii., p. 201, 1870) from the Tertiary of Peru, which is unfigured, may perhaps exceed it. There are about a dozen other species of the Pacific coast Tertiary which have been referred to this genus, but I have not access to material which would enable me to discuss their relations.

The only other species of this genus which has been described from the

eastern Tertiaries of the United States is the Eocene *D. mercenaroidea* Aldrich (Journ. Cinn. Soc. N. Hist., 1887, p. 82; and in Harris, Bull. Pal., ii., p. 172, pl. i., figs. 10, 10a, 1897). This shell has the aspect of a *Meretrix*, and I doubt its pertinence to the genus *Dosinia*.

C. *Lateral teeth and lunule absent.*

Genus **CYCLINA** Deshayes.

Cyclina Deshayes, Traité Elém., i., expl. pl. xiv., *bis*, figs. 20–22, 1849; Cat. Conch. Brit. Mus., i., pp. 3, 30, 1853; *Venus sinensis* Gmelin (syn. excl.); not *Cyclinus* Kirby, Coleoptera, 1837.

Cyclina Mörch, Cat. Yoldi, ii., p. 29, 1853; Römer, Krit. Unters., p. 16, 1857; Mon. *Dosinia*, p. 4, 1862; H. and A. Adams, Gen. Rec. Moll., ii., p. 432, 1857; Stoliczka, Cret. Pel. India, p. 157, 1871; Tryon, Str. and Syst. Conch., iii., p. 180, 1884; Fischer, Man. de Conchyl., p. 1082, 1887.

The soft parts in this genus agree with those of *Dosinia* according to Adams.

The dental formula is $\frac{\text{L. } 0101010.}{\text{R. } 1010101.}$. The fourth, or posterior, right cardinal is nearly obsolete; the one in front of it and the anterior left cardinal are bifid. The shell is suborbicular, nearly equilateral, and plump; the ligament uncovered but deepset; there is neither a defined lunule or escutcheon, the sculpture is faint and chiefly concentric, feebly reticulated by radial striæ; the hinge-plate is broad, the inner margins of the valves crenulate, the pallial sinus moderate in size, acutely angular in front, and obliquely ascending. There is no trace of lateral teeth; the periostracum is polished and translucent, the coloration tinted, without a distinct pattern. The typical forms are denizens of China, Japan, and Korea. The two American forms which have been referred to this genus by Deshayes are discussed under the head of *Cyclinella* and are probably allied to *Mysia*. They differ conchologically by having smooth inner margins to the valves, a defined lunule, no trace of the fourth right cardinal tooth, and purely concentric sculpture.

Genus **CLEMENTIA** Gray.

Clementia Gray, Syn. Brit. Mus., p. 74, 1842; P. Z. S., 1847, p. 184; Pfeiffer, Mal. Blätt., xiv., p. 144, 1868, and xvi., p. 190, 1870; H. and A. Adams, Gen. Rec. Moll., ii., p. 433, 1857; Stoliczka, Cret. Pel. India, p. 157, 1871; Tryon, Str. and Syst. Conch., iii., p. 181, 1884; Fischer, Man. de Conchyl., p. 1084, 1887; *Venus papyracea* Gray.

Blainvillia Hupé, Rév. de Zool., 1854, p. 219; not *Blainvillia* Desvoidy, 1830. *Diptera.*

This remarkable animal is stated by Woodward (Man., p. 306) to have long united siphons and a large crescentic foot such as is found in *Dosinia*. It appears to be now an inhabitant of the Indo-Pacific and west American regions only, but in Eocene and Oligocene times was well represented in tropical northeastern America. Dental formula $\frac{\text{L. } 101010.}{\text{R. } 010101.}$.

Shell thin, inflated, with prominent beaks, a ligament external and enfolding the resilium and extending slightly in front of the beaks; the anterior left and two posterior right hinge-teeth more or less bifid; there are no lateral teeth; the pallial sinus is long, angular, narrow, ascending; valve-margins entire, and the valves delicately sculptured, concentrically striate or undulate, sometimes with oblique decussating striæ.

Clementia dariena Conrad.

Meretrix dariena Conrad, Pacific R. R. Rep., v., p. 328, pl. vi., fig. 55, 1856; not *op. cit.*, vi., p. 72, 1857.

Clementia dariena Gabb, Jour. Acad. Nat. Sci. Phila., 2d Ser., viii., p. 344, pl. xliv., fig. 16, 16a, 1881.

Eocene(?) of Gatun, on the line of the Panama Canal, Newberry; Oligocene of Vamos-a-vamos, near the canal, R. T. Hill; of Sapote, Costa Rica, Gabb; of Santiago de Veraguas, Isthmus of Darien, O. Hershey.

This appears to be a quite characteristic fossil of the middle American Oligocene and has been well figured by Gabb.

Clementia tæniosa Guppy.

Arcopagia tæniosa Guppy, MS.

Clementia tæniosa Guppy and Dall, Proc. U. S. Nat. Mus., xix., p. 327, pl. xxx., fig. 8, 1896.

Tertiary (Oligocene?) beds of Savaneta, Trinidad; Guppy.

This is a more trigonal form than any of the others, but there is little doubt that it is a species of *Clementia*. The type is in the National Museum.

Clementia inoceriformis Wagner.

Venus inoceriformis Wagner, Journ. Acad. Nat. Sci. Phila., viii., p. 51, pl. i., fig. 1, 1839; (extra copies, p. 2, pl. ii., fig. 2, 1838?) Trans. Wagner Inst. Sci., v., p. 7, 1897.

Clementia inoceriformis Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 575, 1864; Meek, Checkl. Mio. Fos., p. 10, 1864; Dall, Trans. Wagner Inst. Sci., v., p. 8, 1897.

Miocene of Porto Bello, St. Mary's River, Maryland, Wagner; also one mile above Plum Point, Maryland, in the layer of clay below the Miocene marl,

Harris; an internal cast from the Miocene clays of Gay Head, Martha's Vineyard, Massachusetts, may possibly be referable to this species.

This species is quite similar to *C. dariena,* but more delicate and with fewer and less prominent undulations.

Clementia Grayi Dall.

PLATE 37, FIGURE 12.

Clementia Grayi Dall, Trans. Wagner Inst., iii., part v., p. 1193, pl. xxxvii., fig. 12, 1900.

Uppermost Oligocene at Oak Grove, Santa Rosa County, Florida; Burns.

Shell thin, convex, rude, concentrically coarsely and irregularly striated, near the beaks concentrically undulated, without lunule or escutcheon; internal margins smooth, adductor scars large, pallial line with a long, narrow, acute sinus extending forward more than two-thirds the way from the posterior to the anterior adductor; cardinal teeth entire, the middle cardinal strongest. Height 55, length 63, diameter 32 mm.

This fine species is not unlike the *C. Vatheletii* Mabille, living in Korea.

The only recent species now known to inhabit American waters is *C. solida* Dall, from the west coast of Mexico; the *C. subdiaphana* Carpenter, recent and fossil in California, is not a member of this genus, and the *C.? gracillima* Carpenter is unidentifiable and founded on a nepionic shell which has not assumed adult characters.

Subfamily MERETRICINÆ.

We now come to a group a large part of which was formerly included in a general way under *Meretrix* or *Cytherea,* but which, on closer study than it has usually received, we are obliged to divide into a number of separate groups or genera. A few general remarks may not be out of place here. This great group contains a large proportion of the *Veneridæ* and many of the more elegant and beautiful forms. They are characterized in general by a smooth or concentrically sculptured surface, often with a vernicose periostracum; smooth inner margins to the valves; a single anterior lateral lamella in the left valve, received in a pit or between two less conspicuous lamellæ in the opposite valve; three cardinal teeth in each valve, of which some may be grooved or bifid; the lunule circumscribed and defined by an incised line, the escutcheon not defined or circumscribed except sometimes by color markings or the absence of surface sculpture; the ligament is external though sometimes depressed, the pallial sinus varying from almost obsolete to deep and angular; siphons of moderate length with papillose orifices, the tubes united for a great

part of their length; the margin of the mantle largely free, more or less papillose; the foot large, hatchet-shaped, not byssiferous. The nymphs and adjacent teeth are sometimes corrugated and the posterior right and anterior left dorsal margins of the valves beyond the hinge-plate are often grooved to receive the bevelled edge of the valve opposite. The shells are always porcellanous. Many names have been given to the different mutations of the type, of which some among the most familiar, as *Dione, Callista, Caryatis,* and *Cytherea,* are preoccupied in other cases.

The forms which are precursors occur as early as the Cretaceous, and even possibly in the Jura, but most of these early forms are not typical, and the genera really begin to assume typical form only in the Eocene.

It is known from the researches of Bernard that the anterior and posterior teeth of the same valve are originally continuous laminæ; thus the superior lamina of the left valve breaks up into the posterior cardinal and the anterior lateral, while the inferior lamina divides to form the two other cardinals of that valve. Ordinarily, the primary connections are lost sight of in the adult, and the cardinal teeth appear to spring from an imaginary centre under the hinge-margin above them. In certain groups, such as *Callocardia, Atopodonta,* or *Veneriglossa,* however, the anterior and posterior right cardinals remain connected as well as the anterior and middle left cardinals, and when the valves are closed the former are inserted above the latter and between them and the hinge-margin, while the middle right cardinal fits in below the united pair of the left valve, thus giving an odd look to the hinge, the reason for which requires some study to recognize. As a whole the *Meretrix* group represents an earlier type than typical *Venus* and one with somewhat more archaic hinge characters. Of these *Callocardia* is unquestionably the least developed.

Owing to the weight of other characters and the fact that no linear arrangement can adequately represent the intricate relationship of such a group as the *Veneridæ,* I have not placed *Callocardia* at the head of the subfamily, but rather at the head of the portion of the series following *Meretrix,* to which it seems, by other characters, to be allied. It may be well, however, to contrast the hinge characters that their features may be clearly understood.

The subfamily as a whole is distinguished from the *Veneridæ* by the invariable presence of one or more anterior lateral teeth. This tooth, when there is but one, is on the hinge-plate of the left valve and is received into a pit, or between two much more feeble anterior laterals in the right valve. In such groups as *Cytherea* Bolten the anterior lateral is degenerate, and in senile specimens nearly obsolete, but traces of it may always be detected in youthful

or normal adult specimens. After passing the groups where the hinge is more or less rugose or peculiar and reaching the most typical forms of the subfamily, such as *Meretrix,* we may observe two types of hinge which in peripheral species, as in their evolution in time, tend towards each other.

A. Meretrices in which the development of the teeth is checked, while the primitive laminæ still connect what would normally be distinct cardinal teeth, as in the left valve the two anterior cardinals, in the right valve the anterior and posterior cardinals, so that when the valves are closed the arch of the left valve spans the right middle cardinal and the arch of the right valve spans that of the left, separating it from the dorsal hinge-margin, while the left posterior cardinal and the anterior laterals are left isolated. The formula is $\frac{\text{L. } 10\overset{\frown}{1010.010}}{\text{R. } 010\underset{\smile}{101.101}}$. There may also be a groove in the left anterior and right posterior dorsal margin to receive the bevelled edge of the opposite valve, but this is not invariable.

B. Meretrices in which the development of the cardinals continues until the right ones are separated from each other, and, in the adult shell, appear to start from a point on the dorsal margin immediately below the umbo. The formula will then be the same as in the preceding division with the omission of the connecting brackets. Traces of the original connection sometimes remain visible (*Amiantis*), but the teeth are in touch with the dorsal margin, from which in *Callocardia* and *Agriopoma* they are separated by a deep groove.

Genus **GRATELOUPIA** Desmoulins

Donax (sp.) Basterot, Géol. env. Bordeaux, p. 84, 1825.

Grateloupia Des Moulins, Bull. Soc. Lin. de Bordeaux, ii., p. 243, 1828; *Donax irregularis* Basterot; Deshayes, Encyc. Méth., iii., p. 173, 1830; Bronn, Leth. Geogn., p. 956, 1838; Ind. Paleont., i., p. 552, 1848; Sowerby, Conch. Man., ed. ii., p. 155, 1842; Hoernes, Fos. Moll. Wiener beck., ii., p. 148, 1870; Fischer, Man. de Conchyl., p. 1081, 1887.

Gratelupia Rang, Man., p. 307, 1829; Lea, Contr. Geol., p. 59, 1833; Potiez et Michaux, Gal. de Douai, ii., p. 419, 1844.

Cytheriopsis Conrad, Am. Journ. Conch., i., p. 146, 1865 (*Cytherea hydana* Conr.), iii., p. 14, 1867; Stoliczka, Cret. Pel. India, p. 154, 1871; not *Cytheropsis* McCoy, 1849, *Crustacea.*

This genus appears to be the precursor of *Tivela,* in which the rugosities of the hinge have not become all fully developed into separate cardinal teeth. It

has three cardinals in each valve, the posterior in one valve more or less fused with a series of obliquely transverse rugosities carved in the inner and ventral mass of the nymphs which interlock between the two valves. There appear to be two groups or subgenera as follows:

Subgenus *Cytheriopsis* Conrad.* Type *Cytherea hydana* Conrad (+ *Gratelupia moulinsi* Lea).

Valves trigonal, the left posterior cardinal fused with the nymphal rugosities, the pallial sinus short and rounded in front. Eocene of Alabama.

Subgenus *Grateloupia* s. s. Type *Donax irregularis* Basterot (+ *Grateloupia donaciformis* Desm.).

Valves elongate oval, the posterior right cardinal fused with the nymphal rugosities, the pallial sinus long and acute, reaching to the vertical of the anterior lateral lamina. Miocene of Bordeaux and Vienna.

Grateloupia (Cytheriopsis) hydana Conrad.

Cytherea hydana Conrad, Fos. Tert. Form., No. 3, p. 36, Aug., 1833; Harris's reprint, pl. xx., fig. 3, 1893.

Gratelupia moulinsi Lea, Contr. Geol., p. 59, pl. ii., fig. 33, Dec., 1833.

Cytheriopsis hydana Conrad, Am. Journ. Conch., i., pp. 7, 146, 1865; iii., p. 14, 1867.

Meretrix Dalli Cossmann, Notes Compl., p. 10, pl. i., figs. 9, 10, 1894; very young shell.

Claiborne sands, Claiborne, Alabama.

Several authors have, with some reason, refused to adopt Conrad's name, though it is six weeks earlier than Lea's, on the ground that his diagnosis, without a figure, was insufficient to identify the species, while Lea gave an excellent diagnosis and figure. However, it is quite certain that the two are identical, and I have therefore used the older name.

Grateloupia (Cytheriopsis) alumensis n. sp.

PLATE 52, FIGURE 14.

Oligocene of the Chipola horizon at Alum Bluff, Florida; Burns.

Shell smooth or faintly concentrically striated, subequilateral, trigonal, moderately thick, base somewhat produced in the middle; beaks pointed, low, subcentral; lunule impressed, bounded by a very delicate incised line, lanceolate;

* If this name should be regarded as too close to *Cytheropsis* McCoy, of earlier date, *Grateloupina* might be substituted.

a raised thread borders the dorsal margin at the side of the ligament; valves moderately convex, the posterior slightly more attenuated than the anterior end, base prominently arcuate; hinge hardly differing from that of *G. hydana,* but the pallial sinus wider and more rounded in front. Length of adult valve, about 38 mm., of the younger but better preserved valve figured 15, height 12.5, diameter 8.0 mm.; diameter of adult 20.0, height 32.0 mm.

This species is easily distinguished from *G. hydana* by its more equilateral, trigonal form, smoother surface, and more ample sinus.

Genus **TRANSENNELLA** Dall.

Transennella Dall, Proc. U. S. Nat. Mus., vi., p. 340, 1883; Fischer, Man. de Conchyl., p. 1080, 1887; Dall, Bull. U. S. Nat. Mus., No. 37, p. 56, 1889; Rep. Porto Rico Moll., p. 486, 1901; Proc. U. S. Nat. Mus., xxix., p. 509, pl. xxxi., figs. 5–7, 1902.

Shell small, trigonal, with lively coloration; smooth and polished or concentrically striate; hinge with three cardinals in each valve, the middle left cardinal bifid; an elongated anterior lateral in the left valve, received in a sulcus in the right valve; lunule defined by an incised line, escutcheon not defined; nymphs without rugosities; pallial sinus angular, free below, obliquely ascending; internal margins of the valves sharply tangentially grooved with numerous sulci. Type *T. conradina* Dall. Florida.

This group makes its first appearance in the Oligocene, since which it has been a characteristic American type. The well-developed typical species, so far as yet known, are all members of the Atlantic fauna. No indication of viviparity has been detected in them. On the Pacific coast, however, a species which is known to be viviparous, the *Venus tantilla* of Gould (*Venus rhysomia* Gabb), occurs Pleistocene and recent on the coast of California. The characteristic sulcations of the margin are, however, feebly developed in the Pacific shell, and further study may perhaps oblige us to separate it from the Atlantic group. At present the fact may be noted that *Transennella tantilla* represents in the Meretricine line the genus *Psephidia* of the Venerine line, the latter being, as far as yet discovered, a purely Pacific type.

The recent Atlantic species of *Transennella* are *T. cubaniana* Orbigny, *T. conradina* Dall, *T. culebrana* Dall and Simpson, and *T. stimpsoni* Dall.

Transennella utica n. sp.

PLATE 57, FIGURE 12.

Oligocene of the Chipola horizon at Alum Bluff, Florida, and on the Chipola River; Dall and Burns.

Shell small, only moderately convex, subtrigonal, inequilateral, polished, with shallow, concentric sulci, less marked in the centre of the disk, diminishing in number and increasing in strength towards the anterior end of the shell; beaks small, erect, acute at the anterior third; lunule narrow, lanceolate, as long as the anterior dorsal slope, slightly impressed, smooth, defined by an impressed line; escutcheon not defined; hinge compact, the anterior left cardinal bifid; the sulcations of the margin well marked but not as dense as in the larger species; the sinus deep, narrow, rounded in front. Length 7.0, height 5.0, diameter 2.5 mm., but usually smaller.

This is the earliest and smallest species, notable for its acute beaks. These shells vary, some being shorter and higher, others more beaked and elongate. All the species vary in much the same way, but, in spite of the difference in outline, there is a recognizable facies to each. Only one or two species occur in any single horizon.

Transennella chipolana n. sp.

PLATE 57, FIGURE 6.

Oligocene of the Chipola River, Florida, at McDonald's Ranch; Dall.

Shell small, short, ovate-trigonal; beaks low, anteriorly directed, near the anterior third; anterior dorsal slope short, straight, with a narrow, cordate, slightly impressed lunule; posterior slope convexly arcuate, posterior end rounded, base evenly arcuate; surface covered uniformly with fine, close, sharp, concentric grooves; hinge and margins normal; pallial sinus ample, deep, rounded in front. Length 5.0, height 4.2, diameter 2.0 mm.

Only a single valve of this species was obtained, but it is well distinguished by its fine, even sculpture, *Chionella*-like outline, and ample sinus.

Transennella santarosana n. sp.

PLATE 57, FIGURE 13.

Oligocene sands of Oak Grove, Santa Rosa County, Florida; Burns.

Shell small, plump, subtrigonal, polished, and sculptured with numerous slightly irregular concentric sulci; beaks small, subcentral, slightly anteriorly directed; lunule cordate, narrow, bounded by an impressed line, striated; hinge with the middle cardinals and the anterior lateral large and conspicuous; pallial sinus wide, short, rounded, not reaching the middle of the valve. Length 6.5, height 5.5, diameter 3.8 mm.

This is easily distinguished from *T. chipolana* by its less sharp and crowded sculpture and its more convex valves.

Transennella carolinensis n. sp.

PLATE 55, FIGURE 4.

Miocene of North Carolina at Magnolia and the Natural Well of Duplin County; Burns, Hodge, etc.

Shell small, subequilateral, cythereæform, rather solid and thick for its size; plump, with low, slightly anteriorly directed beaks; polished, nearly smooth in the middle, towards the ends having somewhat irregularly concentric bevelled sulci; lunule impressed, lanceolate, bounded by an incised line, striated; hinge normal, the middle left cardinal bifid; marginal sulcations strong; pallial sinus short, nearly horizontal, rounded in front. Length 11, height 9, diameter 6 mm.

This species was obtained by Hodge in North Carolina more than sixty years ago and was listed as *Cytherea carolinensis* in several papers and check-lists by Conrad and Meek, but never figured or described. A specimen named by Conrad and collected by Hodge in North Carolina was presented by the latter to the National Institute and subsequently became part of the collection of the National Museum, thus enabling me to recognize the nude name, which I now adopt, as it may have some currency in collections. The species has also been called *Dione carolinensis*. It is more heavy and trigonal than the following species, more equilateral and smoother. It is much larger than any of the species antedating the Miocene.

Transennella caloosana n. sp.

PLATE 57, FIGURE 2.

Upper Miocene of Jackson Bluff, south of Tallahassee, Florida, Vaughan; Pliocene of the Caloosahatchie, Shell Creek, and the Myakka River, south Florida, Dall, Burns, and Willcox; Pleistocene of North Creek, near Osprey, Florida, Dall.

Shell elongate-ovate, inequilateral, with small, acute beaks, anteriorly directed and situated at the anterior third; surface polished, smooth in the middle of the disk; towards each end irregularly concentrically sulcate with rather close, somewhat bevelled sulci; the middle of the disk is often crossed by obscure radial threads, which are sometimes strong enough to crenulate the outer margin; lunule impressed, very narrow, lanceolate, bounded by a sulcate line; hinge with the posterior right and middle left cardinals bifid, margins strongly sulcate, pallial sinus small, linguiform. Length, 13.5, height 10.0, diameter 5.5 mm.

This species is nearest to *T. cubaniana* Orbigny of the recent species, but is larger, with less uniform sulcation and shorter pallial sinus. It is more

inequilateral, more oval and elongate, and with more pronounced sculpture than *T. carolinensis.*

This group is clearly one which prefers relatively warm water. It appears in the transitional Oak Grove sands as the cold water Chesapeake was approaching, but disappears entirely when the latter had fully arrived. Again as the Chesapeake began to give way to the milder influences which brought on the Pliocene, the genus appears in the uppermost Miocene of North Carolina and flourishes through the Pliocene, but retreats to Florida during the Pleistocene, to advance again to the northward, after the passing of the ice age, with the present fauna of the Carolinas.

Genus TIVELA Link.

Tivela Link, Beschr. Nat. Samml. Rostock, ii., p. 152, 1807 (*Venus corbicula* Gmelin); Mörch, Cat. Yoldi, ii., p. 28, 1853; Roemer, Krit. Unters. *Venus,* p. 15, 1857; Mon. *Venus,* i., p. 1, 1864; Stoliczka, Cret. Pel. India, p. 150, 1871; Tryon, Str. Syst. Conch., iii., p. 177, 1884.

Trigona Megerle v. Mühlfeld, Entw. neu. Syst. Schälth., p. 55, 1811 (*Venus mactroides* Born). Not *Trigona* Jurine, 1807, Hymenoptera.

Trigona Schumacher, Essai d'un Nouv. Syst., p. 153, 1817; Gray, Analyst., viii., No. 24, p. 304, 1838; Deshayes, Cat. Conch., i., p. 45, 1853; Tate, Woodward's Man., p. 474, 1871.

Trigonella Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 253, 1837 (*Cytherea crassatelloides* Conrad). Not *Trigonella* Da Costa, Brit. Conch., p. 196, 1778 (= *Mactra* L.).

Pachydesma Conrad, Proc. Acad. Nat. Sci. Phila., vii., p. 31, 1854; Carpenter, Suppl. Rep. Brit. Assoc., 1863, p. 640 (= *Trigonella* Conr., not Da Costa).

Eutivela Dall, Nautilus, v., p. 27, June, 1891 (*Eutivela perplexa* Stearns).

Donax (sp.) Mawe, Conch., pl. ix., fig. 7, 1823.

?Dollfusia Cossmann, Cat. Illustré bas. Paris, i., p. 116, 1886 (*D. crassa* Cossmann); Fischer, Man. de Conchyl., p. 1080, 1887.

This is a very natural group with the remarkable peculiarity of having the armature of the hinge variable among the different species. The cardinals, especially those which are posterior, are sculptured more or less in a longitudinal sense, with sulci or rugosities, and it would seem as if, in the species with an unusual number of teeth, the excess is due to the splitting into several of originally single teeth. However this may be, the dental formula ranges from $\frac{\text{L. 01010101010.010}}{\text{R. 10101010101.101}}$ (*T. radiata* Sowerby) to $\frac{\text{L. 010101.010}}{\text{R. 101010.101}}$ (*T. abaconis* Dall), the latter being quite a small species. The giant of the genus, *T. stultorum,* however, has a dental formula with only four cardinals in either valve.

The genus has a very solid porcellanous shell, more or less trigonal and

subequilateral, with a conspicuous, often caducous, periostracum. The valves close tightly, are usually more or less convex, and are devoid of sculpture though often forcibly colored. The pallial line has a small, wide, short sinus rounded in front. There is on the hinge-margin a single anterior left lateral which is received between two more or less distinctly developed laminæ in the opposite valve. Some of the cardinals towards the middle of the series are usually broad and bifid. The left anterior and right posterior margins of the valves, beyond the hinge-plate proper, are more or less distinctly grooved to receive the bevelled edges of the valve opposite. The periostracum in the typical section is peculiar in having, over a polished substratum, a layer of silvery color and velvety texture which is very easily removed by friction and is always absent from beach-worn specimens.

The genus is divided as follows:

Section *Tivela* s. s. Type *Venus mactroides* Born.

Valves trigonal, with smooth interior margins, and a periostracum superficially pilose when fresh; cardinals varying from four to six in either valve in different species.

Section *Pachydesma* Conrad. Type *Donax stultorum* Mawe.

Shell very large, elongate-trigonal, with smooth interior margins, a vernicose dehiscent periostracum, and four cardinals in each valve.

Section *Eutivela* Dall. Type *E. perplexa* Stearns.

Shell small, elongate, with crenulate interior margins, thin, polished periostracum, three left and four right cardinal teeth.

The genus *Dollfusia* Cossmann is placed hereabouts by Fischer, but I have not been able to examine a specimen. It belongs to the Parisian Eocene.

Tivela jamaicensis n. sp.

Plate 57, Figure 9.

Oligocene of the Bowden marl at Bowden, Jamaica, rare; collected by Henderson and Simpson.

Shell small, thin, plump, smooth, or faintly concentrically striated; beaks nearly central, low pointed, turgid; lunule large, lanceolate, smooth, defined by an impressed line; nymphs short and elevated, dorsal slopes nearly straight, ends bluntly rounded, base slightly arcuate; hinge delicate with three small

cardinals and a rather long, slender anterior left lateral; margins thin, smooth; pallial sinus small, rounded. Length 6.0, height 5.5, diameter 4.0 mm.

This, the only fossil *Tivela* yet obtained in the Atlantic Tertiaries, is small and delicate, belonging to the group of *T. trigonella* Lamarck and *T. abaconis* Dall, of the recent fauna.

Tivela (Pachydesma) stultorum Mawe.

Donax stultorum Mawe, Syst. Conch., pl. ix., fig. 7, 1823; Wood, Ind. Tert. Suppl., pl. ii., fig. 2, 1825.

Trigona stultorum Gray, Analyst, viii., No. 24, p. 304, 1838; Deshayes, Cat. Conch. Brit. Mus., i., p. 46, 1853; Hanley, Rec. Sh., p. 106, 1843.

Cytherea (Trigonella) crassatelloides Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 253, pl. xix., fig. 17, 1837; Hanley, Rec. Sh., 1843, p. 106, pl. xv., fig. 17; Hinds, Zool. Sulph. Voy., p. 65, pl. xxi., fig. 1, 1844.

Cytherea (Pachydesma) crassatelloides Conrad, Proc. Acad. Nat. Sci. Phila., vii., p. 31, 1854; Carpenter, Suppl. Rep. Brit. Assoc., 1863, p. 640, 1864.

Trigona crassatelloides Deshayes, Cat. Conch. Brit. Mus., i., p. 46, 1853; Carpenter, Mazatlan Cat., p. 58, 1857.

Cytherea crassatelloides Sowerby, Thes. Conch., ii., pt. 12, p. 612, pl. cxxvii., figs. 1, 2, 3, 1851.

Cytherea solidissima Philippi, Zeitschr. Mal., viii., p. 74, 1851.

Cytherea æquilatera Römer (not Deshayes), Krit. Unters., p. 60, 1857.

Cytherea Lamarckii Reeve, Conch. Icon., *Cytherea*, pl. iii., fig. 8, 1864; not of Gray, 1838, or Deshayes, 1853.

Cytherea stultorum Reeve, Conch. Icon., *Cytherea*, pl. vi., fig. 22, 1864.

Cytherea crassatelloides Reeve, Conch. Icon., *Cytherea*, pl. i., fig. 3, 1864.

Pachydesma crassatelloides Gabb, Pal. Cal., ii., p. 96, 1868.

Tivela crassatelloides Römer, Mon. *Venus*, i., p. 2, pl. i., fig. 1, pl. ii., fig. 1, 1864; Stearns, Proc. U. S. Nat. Mus., xxi., p. 371, pls. xxiii., xxiv., and xxv., 1898.

Not *Cytherea stultorum* Philippi, Abbild. Beschr., ii., p. 180, pl. xv., fig. 3, 1847.

Pleistocene of California from Santa Barbara to Todos Santos Bay; living from Santa Cruz, California, to Cape St. Lucas and perhaps to Mazatlan, Mexico.

This fine and well-known shell is one of the most characteristic Californian species. *T. (P.) inezana* Conrad, 1857, from the Miocene of the Santa Ynez Mountains, California, is the only other species known as fossil in the United States.

Genus **SUNETTA** Link.

Sunetta Link, Beschr. Rostock Samml., p. 148, 1807; type *Donax scripta* L.; Römer, Krit. Unters., p. 16, 1857; H. and A. Adams, Gen. Rec. Moll., ii., p. 427, 1857 (*S.*

meroë L.); Römer, Mon. *Venus*, ii., p. 1, 1870; Cossmann, Cat. Illustr. bas. Paris, p. 112, 1886.

Cuneus Megerle von Mühlfeld, Mag. Ges. Naturf. Freunde zu Berlin, v., p. 50, 1811 (*Venus meroë* L.); Deshayes, Cat. Conch. Brit. Mus., i., p. 41, 1853; not of Da Costa, 1778.

Meroë Schumacher, Essai, p. 149, 1817 (*V. meroë* L.); Gray, Analyst, viii., p. 303, 1838; Tryon, Syst. Conch., iii., p. 179, 1884; Fischer, Man. de Conchyl., p. 1081, 1887.

Sunettina Jousseaume, Le naturaliste, Sept., 1901, p. 208. Type *S. sunettina* Jousseaume, Aden.

This well-known genus may be separated into sections as follows:

Sunetta s. s.

Shell elongate-ovate, more or less inequilateral, plump, concentrically sulcate or striate. Type *S. scripta* Linné.

Solanderina Dall, 1902.

Shell inflated, smooth, subequilateral, otherwise as in *Sunetta* s. s. Type *S. solandri* Gray.

Sunettina Jousseaume.

Shell suborbicular, compressed, smooth. Type *S. sunettina, menstrualis,* etc.

The dental formula of *Sunetta* is $\frac{\text{L. } 101010.010}{\text{R. } 010101.101}$, the edge of the posterior left cardinal is finely granular, though in *Solanderina* it is smooth. The ligament is external but set in a deeply excavated escutcheon; the impressed lunule is unequally divided, the right portion larger; the posterior end of the shell is shorter than the anterior; the pallial sinus is wide, rather short, and rounded; the inner margins of the valves are conspicuously crenulate. The lateral laminæ are rather elongated.

The genus *Sunetta* is now an inhabitant of tropical seas, West Africa to China and the Indo-Pacific region, but in the Eocene it existed in the Paris basin, several fossil species being reported thence.

Genus **GAFRARIUM** Bolten.

< *Gafrarium* Bolten, Mus. Boltenianum, p. 176, 1798; ed. ii., p. 123, 1819. No type selected; by elimination of *Cytherea* (sp.) Bolten and *Corbis* Cuvier, 1817, *Venus pectinata* Linné remains as type.

= *Crista* Römer, Krit. Unters., p. 15, 1857, *Venus pectinata* L.; Mon. *Venus*, i., p. 173, 1869; Stoliczka, Cret. Pel. India, p. 152, 1871; Tryon, Syst. Conch., iii., p. 179, 1884; Fischer, Man. de Conchyl., p. 1080, 1887.

Paphia Oken, Lehrb. d. Naturg., p. xii. (not p. 732), 1815; *Venus divaricata* Linné; not *Paphia* Bolten, 1798, or Lamarck, 1801.

Paphia Woodward, Man., p. 299, footnote, 1853 (not of Lamarck, 1801, = *Crassatella contraria* Lam.).

<> *Gouldia* C. B. Adams, Cat. Coll., p. 29, 1847; *Thetis cerina* Adams; = *Thetis* Adams, 1845; not Sowerby, 1826; not *Gouldia,* Bonaparte, *Aves,* 1850.

>*Gouldia* Dall, P. Z. S., 1879, p. 131; *G. cerina* Adams; Tryon, Syst. Conch., iii., p. 179, 1884; Fischer, Man. de Conchyl., p. 1080, 1887; Bucquoy, Dautzenberg, and Dollfus, Moll. de Roussillon, ii., p. 334, 1893.

Circe (sp.) Deshayes, Cat. Conch. Brit. Mus., i., pp. 88–90, 1853, and of numerous other authors.

Cista Carus, Prodr. faun. Medit., ii., p. 124, 1889 (?err. typ. for *Crista*). *Venus pectinata* Linné; not *Cista* Hübner, 1816, Lepidoptera.

Contrary to my impression while revising the *Lucinacea,* I find that the name of Bolten must be retained for the group commonly known as *Crista* Römer, as I have explained under the head of *Cytherea* Bolten.

This group has short, papillose siphons, the mantle-edge more or less fringed, and the usual geniculate foot. It is not positively known earlier than the Tertiary. The species referred to it from Mesozoic horizons probably should be referred to *Cyprimeria.*

The genus may be divided into two closely allied subgenera, *Gafrarium* s. s. and *Circe.* A passage towards *Meretrix* is found in the group named *Lioconcha* by Mörch, which was formerly included under *Circe by* some writers.

Subgenus *Gafrarium* Bolten. Type *Venus pectinata* Linné.

Dental formula: $\frac{\text{L. } 0.101010.010}{\text{R. } 0.010101.101}$. Shell equivalve, subequilateral, with a simple or slightly sinuous pallial line, simple or partially faintly grooved cardinal teeth, surface more or less sculptured.

Subgenus *Gafrarium* s. s.

Surface with strong, chiefly radial, more or less dichotomous sculpture, with the posterior slope sculptured differently from the rest; valves moderately convex, the umbones subcompressed with a narrow lunule and feebly defined escutcheon; pallial line simple; the inner margins of the valves crenulate; the ligament sunken but not covered over; the left middle cardinal tooth feebly grooved.

Section *Gouldia* C. B. Adams.

Surface reticulately sculptured, the radials more conspicuous towards the ends of the valves and the concentric sculpture in the middle; no specialized

posterior area; valves with the umbones not compressed, moderately convex; pallial line slightly flexuous behind, inner margins of the valves entire, the cardinals not grooved; the ligament and other characters as in *Gafrarium* s. s.

?Section *Radiocrista* Dall, 1902. Type *Venus pulcherrima* Deshayes, Journ. de Conchyl., viii., p. 381, pl. xiv., figs. 1, 2, 1860. Tertiary.

Shell with the form of *Chionella,* the disk and anterior part elegantly, regularly concentrically sulcate; the dorsal posterior area equally divided between the valves, nearly smooth, separated from the disk by strong radial ribbing; the lunule not definitely circumscribed but indicated by a thickening of its margins and concentrically striated. Interior and geological horizon unknown.

This remarkable fossil is provisionally located here pending further information. It is probably of European Tertiary origin.

Section Gouldia C. B. Adams.

Gafrarium (Gouldia) insulare Dall and Simpson.

Circe (Gouldia) insularis Dall and Simpson, Moll. of Porto Rico, p. 487, pl. lv., fig. 2, 1901.

Oligocene of the Bowden marl, Bowden, Jamaica; living at San Juan and Mayaguez harbors, in Porto Rico, in thirty fathoms sand.

After a careful examination of both recent and fossil specimens I am unable to mention any characters which may be said to constantly differentiate them. On the whole, the fossils are a little more inflated and usually more produced in front, but these features are inconstant.

Gafrarium (Gouldia) erosum n. sp.

Plate 57, Figure 10.

Oligocene of the Chipola River, Calhoun County, Florida; Burns.

Shell rounded trigonal, rather thin, subcompressed, the surface finely, evenly, closely, concentrically sulcate, with a few almost microscopically minute radial striulæ sometimes visible under a lens in the sulci near the ends of the shell; most of the specimens appear to be without radial sculpture; beaks small, pointed, slightly anteriorly directed over a lanceolate lunule bounded by an incised line; hinge normal; pallial sinus barely indicated; inner margins smooth, the right posterior dorsal margin grooved to receive the bevelled edge of the margin of the opposite valve. Length 8.3, height 7.2, diameter 4.0 mm.

This species is especially characterized by its fine, even, concentric sculpture and nearly total absence of radial striæ.

Gafrarium (Gouldia) altum n. sp.

PLATE 57, FIGURE 5.

Oligocene sands of Oak Grove, Santa Rosa County, Florida; Burns.

Shell small, high, rounded trigonal, the beaks small but prominent and rather pustular than pointed; surface with faint, irregular, concentric striæ and wrinkles; towards the base and ends the sculpture is more regular, and, near the ends, cut by faint radial striæ; lunule lanceolate, impressed; pallial line with a broad, shallow wave posteriorly; right posterior dorsal margin deeply grooved, the other portions of the margin smooth. Length 4.5, height 4.5, diameter 3.0 mm.

This species is characterized chiefly by its small size, irregular and feeble sculpture, and wide sinuation of the pallial line.

Gafrarium (Gouldia) metastriatum Conrad.

Cytherea metastriata Conrad, Fos. Medial Tert., p. 14, pl. viii., fig. 5, 1838.

Venus metastriata Orbigny, Prodrome Paleont., iii., p. 108, 1852; Conrad, Am. Journ. Sci., 2d Ser., i., p. 404, 1846; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 79, pl. xxi., fig. 1, 1857; Emmons, Geol. Rep. N. Car., p. 293 (figure excluded), 1858.

Circe metastriata Conrad, Proc. Acad. Nat. Sci. Phila, for 1862, p. 575, 1863; Meek, Checklist Mio. Fos., p. 10, 1864.

Miocene of Suffolk (type locality) and Yorktown, Virginia; of North Carolina at Magnolia and the Natural Well, Duplin County, and Wilmington; of Jackson Bluff and other localities south of Tallahassee in northwest Florida; Pliocene of the Waccamaw district, South Carolina, and of the Caloosahatchie and Shell Creek, De Soto County, Florida.

This species is coarsely sculptured with strong radial striæ distally, the sulci all over the disk sometimes showing radial sculpture. It is perhaps most nearly allied to *Gouldia bermudensis* E. A. Smith of the recent fauna, but that species is on the whole a more elongated form with finer and more regular sculpture and less inflated shell. Originally Conrad regarded the *G. cerina* C. B. Adams as identical with the fossil, an opinion adopted also by Tuomey and Holmes. The species of *Gouldia* are all very similar, but there is difference enough in this case to render it undesirable to unite the fossil and the recent shells. In the case of Emmons it seems almost certain that the shell figured by him as *Venus metastriata* is something quite different, perhaps a Lucinoid form like *Phacoides radians* Conrad. The measurements of *G. metastriatum* sometimes reach: length 16.0, height 14.0; diameter 7.5 mm., but the specimens average smaller.

This type appears confined to Atlantic waters; no species has yet been reported from the Pacific coast of the continent, recent or fossil. The species of this section are the sole representatives in America of the genus *Gafrarium*, either recent or Tertiary, the *Circe carbasea* Guppy being a member of the genus *Pitaria*, section *Hyphantosoma*; *"Psephis" cancellata* Gabb (Journ. Acad. Nat. Sci. Phila., viii., p. 373, pl. xlvii., fig. 74, 1881), from the Pliocene clays of Costa Rica, is very probably a species of *Gouldia*.

Subgenus CIRCE Schumacher.

Circe Schumacher, Essai, p. 152, 1817 (*Venus scripta* L.); Gray, List Brit. An. Brit. Mus., p. 6, 1851; Mörch, Cat. Yoldi, ii., p. 25, 1853; Römer, Krit. Unters., p. 15, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 428, 1857; Stoliczka, Cret. Pel. India, p. 152, 1871; Fischer, Man. de Conchyl., p. 1080, 1887.

<*Circe* Gray, Analyst, viii., No. 24, p. 307, 1838; Deshayes, Cat. Conch. Brit. Mus., i., p. 83, 1853; Tryon, Syst. Conch., iii., p. 179, 1884.

><*Circenita* Jousseaume, Mem. Soc. Zool. de France, i., p. 208, 1888; *Cytherea arabica* Lamarck.

The subgenus may be divided as follows:

Section *Circe* Schumacher.

Surface with only concentric sculpture; valves compressed with smooth, compressed beaks, narrow lunule and escutcheon, the pallial line simple, and the inner margins entire; posterior right cardinal grooved; ligament deeply sunken but not hidden. Type *Venus scripta* Linné.

Section *Parmulina* Dall. Type *Circe corrugata* (Dillwyn) Deshayes.

Surface with the umbonal region coarsely divaricately ribbed, the remainder of the disk with strong concentric sculpture; valves with the umbones flattened, the remainder convex; pallial line slightly flexuous behind; inner margins finely crenulate; lunule and escutcheon narrow, flat; ligament visible though sunken; cardinals entire or faintly grooved.

Section *Circenita* Jousseaume.

Surface feebly concentrically sculptured; valves convex, plump, the umbones not compressed, the posterior slope without specialized sculpture; lunule distinct, narrow; the escutcheon hardly defined, the ligament little sunken; the middle cardinals feebly grooved; the pallial line with a minute sinus; the inner margins of the valves entire.

Genus **LIOCONCHA** Mörch.

Lioconcha Mörch, Cat. Yoldi, ii., p. 26, 1853 (*Venus castrensis* Linné); H. and A. Adams, Gen. Rec. Moll., ii., p. 429, 1857; Römer, Mon. *Venus*, i., p. 147, 1868; Stoliczka, Cret. Pel. India, p. 152, 1871; Fischer, Man. de Conchyl., p. 1080, 1887.

Tropical seas of the old world.

Shell solid, heavy, porcellanous, smooth or concentrically striated, suborbicular; lunule sharply circumscribed, impressed; escutcheon absent; ligament sunken and almost immersed; pallial line slightly flexuous; inner margins smooth; anterior left and posterior right dorsal margins deeply grooved beyond the hinge-plate to receive the bevelled edge of the opposite valve; anterior lateral teeth large and strong; three smooth, stout, entire cardinals in each valve; periostracum thin and smooth.

This group was formerly regarded as a subgenus of *Circe* chiefly on account of its nearly simple pallial line. It is not represented in the American Tertiary, the "*Lioconcha*" *Newcombiana* Gabb, which occurs Pleistocene and recent on the Californian coast, being a species of *Chionella*.

Genus **MACROCALLISTA** Meek.

Macrocallista Meek, Pal. Upper Missouri, p. 179, 1876; type *Venus nimbosa* Solander; Tryon, Syst. Conch., iii., p. 178, 1884; Fischer, Man. de Conchyl., p. 1079, 1887.

Chione Gray, Analyst, viii., p. 305, 1838 (*Venus chione* Linné); P. Z. S., 1847, p. 183; Leach, Syn. Moll. Gt. Brit., p. 302, 1852; not *Chione* Megerle, 1811, or Gray, 1851.

Dione Gray, List Brit. An. Brit. Mus., p. 6, 1851; *Venus chione* Linné; not *Dione* Gray, 1847, or Hübner, *Lepidoptera*, 1816.

Callista Mörch, Cat. Yoldi, ii., p. 27, 1853 (*Venus chione* Linné); Römer, Krit. Unters., p. 15, 1857; H. and A. Adams, Gen. Rec. Moll., ii., p. 424, 1857; Römer, Mon. *Venus*, i., p. 43, 1866; Meek, Pal. Upper Missouri, p. 178, 1876; Tryon, Conch., iii., p. 177, 1884; Fischer, Man. de Conchyl., p. 1079, 1887; Bucquoy, Dautzenberg, and Dollfus, Moll. de Roussillon, ii., p. 322, 1893; not *Calista* (*Poli*) Leach, Syn. Moll. Gt. Brit., p. 305, 1852.

Chionella Cossmann, Cat. Illustré bas Paris, i., p. 105, 1886; Fischer, Man. de Conchyl., p. 1080, 1887. Type *Cytherea ovalina* Deshayes.

This genus, which contains some of the most elegant of the *Veneridæ*, has been called by names which cannot be retained, all of them having been first proposed with a different use. The first binomial author to utilize the name *Callista* (which had been one of Poli's quadrinomials) was Leach, who applied it to *Venus verrucosa* Linné, so that it cannot be used for the present assembly.

The name *Macrocallista* of Meek was intended to designate the *Venus*

gigantea of Gmelin (= *nimbosa* Solander), but this is only sectionally distinct from the forms which have been called *Dione* and *Callista,* and Meek's name will therefore have to be taken as covering them both, while a new sectional name is adopted, which was proposed by Cossmann for Eocene members of the group named *Dione* by Gray in 1838.

The characteristics of the genus are as follows:

Shell ovate, solid, porcellanous, microscopically radially lineated, polished, smooth or concentrically waved, usually with a vivid coloration and vernicose periostracum; lunule definitely limited, unequally divided, the right portion slightly larger, internal margins smooth; pallial sinus ample, pointed in front; left anterior and right posterior dorsal margins grooved to receive the edge of the other valve; the anterior laterals and three cardinal teeth present in each valve, the right posterior cardinal more or less distinctly grooved or bifid.

Section *Macrocallista* s. s.

Shell elongated, the pallial sinus short, the nymphs smooth, the posterior cardinals very slender and elongated. Type *Venus nimbosa* Solander. Florida.

Section *Chionella* Cossmann, 1886.

Shell ovate-trigonal, the posterior cardinals short, the pallial sinus reaching to the middle of the shell, or nearly. Type *Cytherea ovalina* Lamarck. Parisian Eocene.

In the recent species, like *Venus chione,* the sinus is nearly horizontal, its apex pointing below the anterior adductor scar; in the Eocene species it is more elevated, and in *C. ovalina,* which Fischer selected as type (Cossmann having mentioned no type), it points to the upper margin of the anterior scar. But this distinction seems insufficient to base any further subdivision upon. In a general way this section differs from *Macrocallista* proper in being shorter and more trigonal, the other characters mentioned being functions of the difference in form.

Macrocallista reposta Conrad.

Cytherea reposta Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 132, 1834; Fos. Medial Tert., p. 15, pl. ix., fig. 2, 1838.

?Cytherea pandata Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 132, 1834 (young shell).

Cytherea reporta Emmons, Geol. Rep. N. Car., p. 294, fig. 223*a*, 1858; not *C. reposta* Emmons, *loc. cit.,* fig. 222 (= *C. albaria* Say).

Dione reposta Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863; Meek, Checkl. Miocene Fos., p. 10, 1864.

Miocene of Suffolk and the Nansemond River eighteen miles below Suffolk, and of the York River, Virginia; of North Carolina at Wilmington, Newberne, the Natural Well, and Magnolia, Duplin County; and sixteen miles southwest of Tallahassee, Florida.

This fine species is shorter and broader than *M. nimbosa* and thinner and more elongated than *M. albaria*. A slightly compressed band radiates from the beaks to the lower posterior margin.

Macrocallista pittsburgensis Dall.

PLATE 36, FIGURE 22; PLATE 43, FIGURE 15.

Meretrix (Callista) pittsburgensis Dall, Trans. Wagner Inst., iii., pp. 1192, 1199, pl. xxxvi., fig. 22, xliii., fig. 15, 1900.

Eocene of Pittsburg, Oregon, in hard black shale; J. S. Diller; rather abundant in the locality cited.

Shell very inequilateral, subcompressed, elongate oval, with rather prominent, irregular, incremental lines; covered with a conspicuous periostracum which is preserved in the fossils; beaks small, low, somewhat anteriorly directed; lunule lanceolate, smooth, rather large, bounded by an incised line; anterior dorsal slope short, straight; posterior slope moderately arcuate, long; ends rounded, base arcuate; hinge normal; posterior right cardinal bifid; pallial sinus pointed in front, nearly reaching the middle of the shell. Length 36, height 21, diameter 11 mm.; the beaks one-fifth of the length from the anterior end.

Macrocallista albaria Say.

Cytherea albaria Say, Am. Conch., pl. lix., fig. 1–2, 1834; Binney's reprint, do., p. 219, 1858; Conrad, Fos. Medial Tert., p. 13, pl. viii., fig. 2, 1838 (Santee River, S. Carolina).

Dione densata Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 586, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864; Am. Journ. Conch., iv., p. 278, 1869.

Callista densata Conrad, Am. Journ. Conch., iv., p. 278, pl. xix., fig. 2, April, 1869 (Petersburg, Va.).

Callista virginiana Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, pp. 575, 586, 1863; Am. Journ. Conch., v., p. 39, pl. ii., fig. 1, July, 1869 (Petersburg, Va.).

Dione idonea Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864.

Dione albaria Meek, Checkl. Miocene Fos., p. 9, 1864.

Dione virginiana Meek, *op. cit.*, p. 10, 1864.

Cytherea reposta Emmons, Geol. Rep. N. Car., p. 294, fig. 222, 1858; not of Conrad.

Miocene of the lower clay bed at Plum Point, Maryland; of the York River and Petersburg, Virginia; of Edgecombe County, North Carolina, and the Santee River, below the Congaree junction, in South Carolina.

This species has suffered from the failure of Mr. Conrad's memory and other faculties towards the end of his life. Say described the species from South Carolina and figured a half-grown valve. Conrad in 1838 copied Say's figure and description. In the sixties he became impressed with the idea that the shells from Petersburg represented a different species from that of Say, and in his endeavors to get this idea recorded in print he renamed his own copy of Say's figure (*idonea*), and gave names to a pathological young shell (*densata*) and to the full-grown adult from Virginia (*virginiana*). The species appears to be subject to a pathological excessive deposit of shell substance inside the pallial line, as remarked by Say. The old shells are shorter and broader in proportion than the young; an occasional healthy specimen has the shell not much thicker than *M. nimbosa*. I see no reason for more than one specific name.

Macrocallista nimbosa Solander.

Venus nimbosa Solander, Portland Cat., p. 175, No. 3761, 1786; after Favanne, pl. xlix., fig. I[1].

Venus gigantea Chemnitz, Conch. Cab., x., p. 354, pl. clxxi., fig. 1661, 1788; Gmelin, Syst. Nat., vi., p. 3282, 1792; Dillwyn, Descr. Cat. Rec. Sh., i., p. 202, 1817; Encyc. Méth., pl. cclxxx., fig. 3, 1797; Bosc, Hist. Nat. Coq., iii., p. 59, 1801; Wood, Ind. Test., p. 40, pl. viii., fig. 100, 1825.

Pectunculus nimbosa Humphrey, Cat. Calonn., p. 49, 1797.

Paphia ala-avis Bolten, Mus. Bolt., p. 175, 1798; ed. ii., p. 122, 1819.

Cytherea gigantea Lamarck, An. s. Vert., v., p. 564, 1818; De Kay, Zool. N. Y., Moll., p. 216, 1843; Hanley, Rec. Sh., p. 97, 1843; Conrad, Am. Journ. Sci., 2d Ser., ii., p. 44, 1846; Sowerby, Thes. Conch., ii., p. 628, pl. cxxxi., fig. 86, 1851.

Dione gigantea Deshayes, Cat. Conch. Brit. Mus., i., p. 80, 1853; Reeve, Conch. Icon., xiv., *Dione*, pl. v., fig. 17, 1863.

Cytherea multiradiata Menke, Verzeichn. Conch., No. 2668, 1830.

Cytherea gigantea Conrad, Tert. Sh. in Morton, Syn. Org. Rem. App., i., p. 2, 1834; not of Sowerby, in Philippi, Abb. und Beschr., *Cytherea*, pl. vii., fig. 1, = *Dosinia* sp.

Callista gigantea Römer, Mon. *Venus*, i., p. 54, pl. xv., fig. 1, 1866; Chemn., Man. Conch., ii., p. 87, fig. 382, 1862; H. and A. Adams, Gen. Rec. Moll., ii., p. 425, 1857; Holmes, P.-Pl. Fos. S. Car., p. 36, pl. vii., fig. 3, 1860; Tryon, Am. Mar. Conch., p. 160, pl. xxix., fig. 396, 1874.

Callista (*Macrocallista*) *gigantea* Meek, Pal. Upper Missouri, p. 179, 1876.

Cytherea (Callista) gigantea Dall, Bull. U. S. Nat. Mus., No. 37, p. 56, 1889.
Callista nimbosa Whitfield and Hovey, Bull. Am. Mus. N. Hist., xi., p. 462, 1901.

Pliocene of the Caloosahatchie beds, at Shell Creek, Alligator Creek, Myakka River, and on the Caloosahatchie River, Florida; Pleistocene of Simmons Bluff, South Carolina, and North Creek, near Osprey, Florida; recent from the vicinity of Cape Hatteras, North Carolina, south to the Florida Keys (Cuba?), west to Mobile, and the coast of Texas at Matagorda Bay.

In the fossil specimens the anterior lateral is apt to be shorter and more pustular, the pallial sinus slightly deeper, and the posterior right cardinal shorter and more distant from the nymph, but these differences are not invariable and I see no reason for separating the two forms even varietally.

Macrocallista acuminata n. sp.

PLATE 57, FIGURE 3.

Oligocene of the silex beds at Ballast Point, near Tampa, Florida, and of the Chipola beds at Alum Bluff, Chattahoochee River, Florida; Dall.

Shell smooth, polished, with faint indications of incremental lines, very inequilateral; the beaks at the anterior fourth or nearly so; the lunule narrowly cordate, impressed, not sharply circumscribed; anterior end rounded, base evenly arcuate; shell sometimes a little rostrate near the posterior end; posterior dorsal slope slightly arcuate; posterior end elongated, rather sharp; hinge normal; pallial sinus nearly horizontal, pointed behind, in the young reaching forward more than half the length of the shell. Length 28, height 18, diameter 9 mm. Fully adult specimens, according to fragments obtained, reach a length of 80 mm.

This species is not unlike *M. reposta* Conrad of the Miocene, but is more inequilateral and more acute behind. It probably does not attain the size of the Miocene form, which is often one hundred and twenty millimetres in length and appears to have a shorter pallial sinus and a more elongate and distant anterior lateral tooth.

Macrocallista (Chionella) marylandica Conrad.

Cytherea marylandica Conrad, Am. Journ. Science, 1st Ser., xxiii., p. 343, 1833; Fos. Medial Tert., p. 15, pl. ix., fig. 1, 1838; Bull. Nat. Inst., ii., pp. 183, 185, 1842.
Dione marylandica Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864; Whitfield, Moll. of the Miocene Form. N. J., p. 74, pl. xiii., fig. 1, 1895.

Miocene of the artesian well at Atlantic City, New Jersey; of Maryland, near Easton, on the Choptank River, on the Patuxent at Jones Wharf, at the mouth of Parker's Creek, and three miles north of Plum Point Wharf, Calvert County; from the marls near Skipton, and at Calvert Cliffs, Maryland.

This is the largest and finest species in our Tertiary. The posterior right cardinal is bifid and the edge of the fan-shaped anterior right cardinal in all the specimens I have seen is transversely puckered or rugose, though I am not sure that in this case this peculiarity may not be pathological. The pallial sinus is short.

Macrocallista (Chionella) maculata Linné.

Venus maculata Linné, Systema Naturæ, ed. x., p. 686, 1758; ed. xii., p. 1132, 1767.

Cytherea maculata Lamarck, An. s. Vert., v., p. 566, 1818; Sowerby, Conch. Man., fig. 117d, 1842; Thes. Conch., ii., p. 629, pl. cxxxi., fig. 97, 1851.

Chione maculata Gray, Analyst, viii., p. 306, 1838.

Dione maculata Deshayes, Cat. Conch. Brit. Mus., p. 57, 1853.

Callista maculata Mörch, Cat. Yoldi, ii., p. 28, 1853; Gabb, Journ. Acad. Nat. Sci. Phila., 2d Ser., viii., p. 344, 1881.

Meretrix dariena Conrad, App. Blake's Geol. Rep., H. Doc., 129, p. 18, 1855; not P. R. R. Rep., v., p. 328, pl. vi., fig. 55, 1856 (= *Clementia* sp.).

Cytherea dariena Conrad, P. R. R. Rep., vi., p. 72, pl. v., fig. 21, 1857.

Oligocene of the Chipola beds on the Chipola River and at Alum Bluff, Chattahoochee River, Calhoun County, Florida; of the Oak Grove sands at Oak Grove, Santa Rosa County, Florida; and at Shoal River, Walton County, Florida; Pliocene of the Caloosahatchie beds, on the Caloosahatchie, Shell Creek, Alligator Creek, and of the Limon clays of Costa Rica; recent from Cape Hatteras, North Carolina, south to the West Indies and Cape San Roque, Brazil, and west to Texas.

This is one of the most elegant species of the group, and after careful study I have been unable to find any constant characters which would serve to separate the Oligocene from the recent shell. The Chipola specimens average smaller than the recent ones, and the Costa Rica fossils are shorter in proportion than the average of those now living, but both features may be accidental and are paralleled by recent individuals examined. During the cold Miocene epoch this species migrated to more congenial seas, but returned with the milder Pliocene and has since remained on our coasts. Conrad named two species *Meretrix dariena,* one of which is identified with this by Gabb, and I

think correctly, the other being a *Clementia* already discussed in this memoir (see p. 1235).

In *M. maculata* the pallial sinus is ample and rises more from the horizontal than in the species previously mentioned, but not as high as in the Parisian forms. It is variable in acuteness, some specimens having the anterior part pointed, others linguiform, and still others rather blunt, as if obliquely truncated.

Callista cuneata Gabb, 1881, from the Pliocene clays of Costa Rica, is evidently congeneric, and differs, according to Gabb, from *M. maculata* by its straight instead of convex posterior slope.

Cytherea floridana Conrad, 1846, appears to belong hereabouts, but I have seen no specimens from Ballast Point which agree with Conrad's figure in the *American Journal of Science* (p. 400) and his description is quite insufficient.

Genus **AMIANTIS** Carpenter.

Amiantis Carpenter, Suppl. Rep. Brit. Assoc. for 1863, pp. 526, 640, 1864 (*Cytherea callosa* Conr.); Ann. Mag. N. Hist., xv., p. 178, 1865; Römer, Mon. *Venus*, i., p. 140, 1868; Tryon, Syst. Conch., iii., p. 178, 1884; Fischer, Man. de Conchyl., p. 1079, 1887.
Amyantis Stoliczka, Cret. Pel. India, p. 151, 1871.

Shell large, solid, ovate, concentrically waved, with vernicose periostracum; lunule and a linear escutcheon defined by an impressed line; inner margins smooth; pallial sinus ample, acute in front, free below, slightly ascending; three cardinals in each valve, the anterior one very thin, anterior laterals large and strong. Type *Cytherea callosa* Conrad, 1838 (+ *Dione nobilis* Reeve, 1849).

Section *Amiantis* s. s.

Shell, except when abnormally thickened, with two obscure radial ribs internally near the middle of the disk; posterior cardinals elongated, strong, the right one bifid; the other teeth entire; the posterior left cardinal and the edge of the right nymph rugose; the posterior dorsal margin beyond the hinge-plate grooved to receive the edge of the opposite valve.

Section *Eucallista* Dall, 1902.

Shell with the posterior cardinals short; the opposite faces of the nymphs with interlocking rugosities, the teeth smooth, the interior without radial ridges. Type *Cytherea purpurata* Lamarck; Reeve, Conch. Icon. *Dione*, pl. viii., fig. 32, 1863.

This shell has a hinge recalling that of *Venus mercenaria* and is a strictly Brazilian species, confused by Deshayes with one from West Columbia, on the Pacific coast. It was called *Chione purpurascens* by Gray in 1838. Lamarck himself noted the peculiarity of the hinge, which does not seem to have been referred to since.

Amiantis callosa Conrad.

Cytherea callosa Conrad, Journ. Acad. Nat. Sci., vii., p. 252, 1837.

Venus callosa Sowerby, Thes. Conch., ii., p. 712, pl. cliv., figs. 44, 45, 1853.

Dosinia callosa Carpenter, P. Z. S., 1856, p. 216.

Amiantis callosa Carpenter, Ann. Mag. N. Hist., 3d Ser., xv., p. 178, 1865; Suppl. Rep. Brit. Assoc., p. 640, 1864; Gabb, Pal. Cal., ii., p. 96, 1869.

Dione nobilis Reeve, P. Z. S., 1849, p. 126; Conch. Icon., xiv., *Dione*, pl. iv., fig. 15, 1863.

Pleistocene of Southern and Lower California, at San Pedro, San Diego, Todos Santos Bay, etc.; living from Santa Barbara to the Gulf of California.

This splendid shell is one of the most characteristic types of the Southern Californian coast. It varies in relative length, the short suborbicular form being Reeve's *Dione nobilis;* the more elongated shell is that originally described from a young specimen by Conrad. This reference to it is included here, as it is the only representative on our coast of the genus to which it belongs.

Genus **MERETRIX** Lamarck.

Meretrix Lamarck, Prodrome, p. 85, 1799 (*Venus meretrix* Linné); Syst. des An. s. Vert., p. 122, 1801; Bosc, Hist. Nat. Coq., iii., p. 42, 1801; Froriep's Duméril, Zool. Anal., p. 169, 1806; Blainville, Man. Mal., p. 556, 1825; Gray, P. Z. S., 1847, p. 183; Deshayes, Cat. Conch. Brit. Mus., pp. 4, 34, 1853; Mörch, Cat. Yoldi, ii., pp. 25, 28, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 423, 1857; Römer, Krit. Unters., p. 14, 1857; Mon. *Venus*, i., p. 25, 1865; Fischer, Man. de Conchyl., p. 1079, 1887.

Citherea Roissy (as of Lam.), Moll., vi., pp. 329, 336, 1805 (*Venus meretrix* L.).

Cytherea Roissy, *op. cit.*, p. 339, 1805 (*C. lusoria* Lamarck); Lamarck, Ann. du Museum, vii., p. 133, 1806; An. s. Vert., v., p. 561, 1818; Brown, Zool. Textb., p. 449, 1833; Gray, Analyst, viii., p. 303, 1838; Mörch, Yoldi Cat., ii., p. 25 (in syn.), 1853; Römer, Krit. Unters., p. 14, 1857; Stoliczka, Cret. Pel. India, p. 150, 1871; Tryon, Syst. Conch., iii., p. 177, 1884; not *Cytherea* Bolten, 1798.

Cytherœa Defrance, Dict. Sci. Nat., xii., p. 421, 1818; Sowerby, Thes. Conch., ii., p. 611, 1851.

Nympha Mörch, Cat. Yoldi, ii., p. 25, 1853, as of Martini (non-binomial) in Verz., 1774; not *Nympha* Fitzinger, *Reptilia*, 1826, or Krause, *Lepidoptera*, 1838.

Shell trigonal, plump, subequilateral, thin, smooth, with a vernicose periostracum and a peculiar olivaceous tone of coloration; lunule and escutcheon not distinctly defined; cardinals three in each valve, with well-marked anterior laterals; the middle left and two anterior right cardinals entire, smooth, the others grooved or bifid; right nymph and posterior left cardinal corrugated; dorsal margins, beyond the hinge-plate, grooved to receive the edge of the opposite valve; internal margins smooth, the pallial line with a shallow arcuate flexuosity but no angular sinus.

Distribution chiefly in the seas of Japan, China, and the Asiatic islands in the western Pacific.

Genus **CALLOCARDIA** A. Adams.

Callocardia A. Adams, Ann. Mag. Nat. Hist., 3d Ser., xiii., p. 307, 1864 (*C. guttata* Ads.); E. A. Smith, Chall. Rep., Biv., p. 155, 1885; Dall, Bull. Mus. Comp. Zool., xii., p. 274, 1866 (ex parte); do., xviii., p. 439, 1889; Proc. U. S. Nat. Mus., xii., p. 268, 1890; xviii., p. 17, 1896; E. A. Smith, Proc. Mal. Soc. Lond., iv., p. 81, 1900.

Caryatis Sowerby, P. Z. S., 1888, p. 212; E. A. Smith, Proc. Mal. Soc. Lond., iv., p. 81, 1900; not *Caryatis*, Hübner, *Lepidoptera*, 1816.

<*Caryatis* Römer, Mal. Blätt., ix., p. 58, 1862 (= *Pitar* Römer, 1857, olim); Mon. *Venus*, i., p. 79, 1867; Stoliczka, Cret. Pel. India, p. 151, 1871; Tryon, Syst. Conch., iii., p. 178, 1884; not of Hübner, 1816.

Veneriglossa Dall, Bull. Mus. Comp. Zool., xii., p. 275, Sept., 1886 (*Cytherea vesica* Dall); Bull. U. S. Nat. Mus., No. 37, p. 56, 1889; Proc. U. S. Nat. Mus., xii., p. 270, 1889.

Atopodonta Cossmann, Cat. Illustré, bas. Paris, i., p. 98, Oct., 1886 (*A. coniformis* Desh. Cossm.); Mém. Soc. Roy. Mal. de Belgique, xxi., p. 110, 1887; Fischer, Man. de Conchyl., p. 1088, 1887.

Shell ovate, plump, thin, concentrically striated, with more or less involute umbones; pallial sinus nearly obsolete; lunule feebly circumscribed, not impressed; escutcheon not defined; left anterior and right posterior dorsal margins beyond the hinge-plate grooved to receive the edge of the opposite valve; inner margins of the valves entire. Type *Callocardia guttata* A. Adams.

The group begins in the Eocene and is widely distributed in the warmer seas.

Subgenus **AGRIOPOMA** Dall.

Agriopoma Dall, Proc. U. S. Nat. Mus., xxiv., p. 509, 1902.

This group differs from *Callocardia* by its large, heavy, and chalky shell without polish or coloration, and by its deep and angular pallial sinus and less involute umbones. Type *Cytherea texasiana* Dall, 1892.

This group is found in the Miocene, and in recent times has a more northern distribution than *Callocardia*. Some of the peripheral species show an approach to the dentition of species of *Pitaria*, but are retained here on the basis of the other characters.

Callocardia (Agriopoma) sincera n. sp.

PLATE 55, FIGURE 12.

Oligocene of the Chipola horizon at Alum Bluff and on the Chipola River, and probably at Ballast Point, Tampa Bay, in the silex beds.

Shell small, short, ovate, very slightly rostrate behind, with low, pointed, anteriorly directed beaks and a large lanceolate lunule defined by an incised line; surface finely, closely, concentrically wrinkled, with two obscure ridges radiating from the beak behind, of which the anterior one forms a slight angle where it intersects the base; hinge solid, normal; posterior right cardinal bifid; posterior dorsal margin deeply grooved to receive the bevelled edge of the opposite valve; pallial sinus short, angular, ascending. Length 20.75, height 17.5, diameter 10.0 mm.

This species, though much smaller and with the sculpture more clean-cut, has the general features of *C. Sayana*, which succeeds it in the Miocene and of which it may be regarded as the precursor. The slightly pointed and rostrate posterior end is peculiar to it.

Callocardia (Agriopoma) gatunensis n. sp.

PLATE 54, FIGURE 1.

Oligocene of the Gatun beds near Gatun, on the line of the Panama Canal, Rowell and Hill; near the line of the railway at Monkey Hill, Newberry and Hill; at Ponton, St. Domingo, and at Clairemont, St. Ann's Parish, Jamaica, West Indies.

Shell moderately large, thin, inflated, ovate; with low, incurved beaks over a large, cordate lunule, defined by a feebly impressed line; ligament narrow, the margins adjacent to it marked by a raised thread; anterior dorsal slope short, straight, the beaks being near the anterior fifth of the shell and the margins raised above the general surface, where they cross the lunule; anterior end rounded, base evenly arcuate, posterior end broadly rounded, posterior dorsal border moderately convex; hinge delicate, anterior lateral small and closely adjacent, posterior right cardinal bifid and rather widely separated from the middle cardinal; pallial sinus ascending, linguiform, extending through

the posterior third of the shell; muscular impressions rather large. Length 38, height 31, diameter 21 mm.

This species appears to be abundant at Gatun and in St. Domingo. The sculpture is only of fine, feeble, close, concentric wrinkles, emphasized distally. It is remarkable for its inequilateral and inflated form. It differs from *C. sapotensis* Gabb, of the Costa Rica Oligocene, in its less triangular and more inflated form, the absence of any anterior projection, and the less equilateral valves.

Callocardia (**gatunensis** variety) **multifilosa** Dall.

PLATE 54, FIGURE 15.

In the Oligocene with the last species near Gatun, Rowell; also 10.5 kilometers west of Colon, Hill; and at Ponton, St. Domingo.

Shell of moderate size, cordate, inflated; the beaks high and incurved; the lunule large and feebly defined by an impressed line; form and other features essentially as in *C. gatunensis*, but the sculpture, which in the latter is polished and in the middle of the disk less pronounced, is in this variety nearly uniform over the surface and raised in small, crowded, thread-like ribs. This gives quite a different aspect to the shell, which seems to justify the application to it of a varietal name.

Callocardia sp. indet.

Oligocene of the Bowden beds, at Bowden, Jamaica, and at Vamos-a-vamos on the line of the Panama Canal.

A species of *Callocardia*, represented by specimens too young to exhibit its final form, occurs at the localities mentioned, and is referred to here in order that the fauna of the beds may be enumerated as fully as possible. Many of the specimens are almost circular, others more ovate, but none has assumed the adult characteristics.

Callocardia (**Agriopoma**) **Sayana** Conrad.

PLATE 54, FIGURE 16.

Cytherea convexa Say, Journ. Acad. Nat. Sci. Phila., iv., p. 149, pl. xii., fig. 3, 1824; not of Brongniart, in Cuvier, 1811.

<*Cytherea convexa* (*ex parte*) Conrad, Journ. Acad. Nat. Sci. Phila., vi., p. 261, 1831; Gould, Inv. Mass., p. 84, 1841; Wheatley, Cat. Coll., p. 7, 1842; De Kay, Zool. N. Y., v., p. 216, 1843; Mighels, Boston Journ. Nat. Hist., iv., p. 320, 1843; Sowerby, Thes. Conch., ii., p. 638, 1851.

<*Cytherea Sayana* Conrad, Am. Journ. Sci., xxiii., p. 345, 1833; Journ. Acad. Nat. Sci. Phila., vii., p. 124, 1834; Ravenel, Cat. Coll., p. 4, 1834; Emmons, Geol. Rep. N. Car., p. 294, fig. 221, 1858.

Meretrix Sayana Conrad, Proc. Acad. Nat. Sci. Phila., vii., p. 30, 1854.

Dione Sayana Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 1863; Meek, Mioc. Checkl., p. 10, 1864.

Venus Sayana Orbigny, Prodr. Pal., iii., p. 108, 1852; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 83, pl. xxi., fig. 9, 1857.

Caryatis plionema Conrad, Am. Journ. Conch., iv., p. 278, pl. xx., fig. 3, 1869..

Callista convexa Tryon, Am. Mar. Conch., p. 161, 1873.

<*Cytherea Sayana* Dall, Nautilus, vi., p. 52, 1892.

Uppermost Oligocene of Oak Grove, Santa Rosa County, Florida; Miocene of Maryland at Little Cove Point, Jones Wharf, the Choptank River, and St. Mary's; of Virginia at Petersburg, various localities on the York River, Grove Wharf and Windmill Point on the James River, and near Suffolk; of North Carolina at Wilmington, and the Natural Well, Duplin County; of South Carolina near Darlington at Shell Branch; of Florida in the Miocene bed at Alum Bluff and sixteen miles southeast of Tallahassee at Jackson Bluff; Pliocene of Nixon's marl bed on the Waccamaw River, South Carolina, and of the Caloosahatchie beds in south Florida; Pleistocene at Wailes Bluff, near Cornfield Harbor, Maryland.

The species has not yet been identified in the recent state. The adult and fully developed specimens differ from *C. morrhuana* by their high, subtriangular form, broad and heavy hinge, and shorter pallial sinus. They do not have the posterior basal flexure and consequent rostration of the posterior end which is the distinguishing mark of *C. subnasuta,* which, however, may prove to be only a special variety, though I have seen none which attained the size of adult *Sayana. Caryatis plionema* Conrad is simply an adult *Sayana.*

Callocardia (Agriopoma) parkeria Glenn.

St. Mary's, Maryland, Miocene; Maryland Geological Survey.

This species is easily distinguished from its allies by its more compressed form and the anterior prolongation of the valves below the lunule. The pallial sinus is notably small, sharply triangular, and ascends at an agle of forty-five degrees.

Callocardia (Agriopoma) morrhuana Linsley.

Plate 54, Figure 14.

Cytherea morrhuana Linsley (name only), Am. Journ. Sci., 1st Ser., xlviii., p. 276, 1845; Gould, *op. cit.,* 2d Ser., vi., p. 233, 1848 (as identical with the recent *C. convexa* Say).

Cytherea convexa Conrad (not Say), Journ. Acad. Nat. Sci. Phila., vi., p. 261, 1831; Gould, Inv. Mass., p. 84, pl. iii., fig. 49, 1841; De Kay, Zool. N. Y., v., p. 216, pl. xxvii., fig. 279, 1843; Sowerby, Thes. Conch., ii., p. 638, pl. cxxxii., fig. 119, 1851; Mighels, Boston Journ. Nat. Hist., iv., p. 320, 1843, and many other authors.

Cytherea Sayana Conrad, *ex parte,* Am. Journ. Sci., xxiii., p. 345, 1833; Ravenel, Cat. Coll., p. 4, 1834.

Dione convexa Deshayes, Cat. Conch., Brit. Mus., p. 71, 1853; Reeve, Conch. Icon., xiv., pl. x., fig. 40, 1863.

Callista convexa H. and A. Adams, Gen. Rec. Moll., ii., p. 425, 1857; Verrill, Inv. An. Vineyard Sd., p. 681, 1873.

Callista Sayana Tryon, Am. Mar. Conch., p. 160, pl. xxix., fig. 398, 1873; Verrill, Inv. An. Vineyard Sd., p. 682, 1873.

Cytherea Sayii Perkins, Proc. Bost. Soc. Nat. Hist., xiii., p. 147, 1869.

Miocene of the York River, Virginia, at numerous localities, and of Shell Branch, near Darlington, South Carolina; Pleistocene of Wailes Bluff, near Cornfield Harbor, St. Mary's County, Maryland; living from Prince Edward's Island south to Cape Hatteras, North Carolina, in moderate depths of water.

This is a cold-water species and is missing from the warmer Pliocene, where *C. Sayana* survives, the latter bearing to the former in Tertiary time such a relation as the *C. aresta* of Porto Rico does to the existing *C. morrhuana.* Some writers in allotting names have endeavored to show that the name *Sayana* should be preserved for the recent shell on the ground that Conrad so applied it. It is true that he did so apply it as an afterthought. But it was proposed by him originally to replace the preoccupied name of a fossil species described by Say, and the fact remains that it can be properly applied to nothing else. That the fossil and recent forms were at one time confounded has nothing to do with the question of nomenclature, since the name *convexa,* which *Sayana* was to replace, was originally applied to the fossil form, without any reference to the recent one. Neither Conrad nor any other writer can alter this fact, which binds the application of the substitute irrevocably to the fossil. The first name subsequently applied to the recent shell as such is that of Linsley as identified from the types by Gould, which must be and is therefore here adopted.

There is little difficulty in discriminating between adult *C. Sayana* and the recent shells, unless in the case of some specimens of the upper Miocene, which I believe to be a mutation of *Sayana,* but which vary (as might be expected, theoretically) towards the type which is later fixed in the recent form. As some students might regard these as conspecific with *morrhuana* I note

them here, but they all appear to me to be immature, and might when adult have taken on more distinctive features. I have seen no unmistakable fossil *morrhuana* except from the Pleistocene.

Callocardia (Agriopoma) subnasuta Conrad.

Cytherea subnasuta Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 28, 1841; Journ. Acad. Nat. Sci. Phila., viii., p. 183, 1842; Fos. Medial Tert., p. 72, pl. xli., fig. 3, 1845 (Calvert Cliffs, Md.).

Venus subnasuta Orbigny, Prodr. Pal., iii., p. 108, 1852.

Miocene of Maryland at Cove Point, Plum Point, Jones Wharf, Calvert Cliffs, and other points in St. Mary's County, and of Virginia at Yorktown. ?Miocene of the Peedee River, South Carolina (Tuomey and Holmes).

It is with considerable doubt that I admit this form to specific rank. The National Museum contains a specimen named by Conrad from the original locality, and it is certainly more produced behind and more rostrate than either *C. Sayana* or *C. morrhuana,* but in all other respects appears identical with *C. Sayana.* It also appears to be rare, and excites a suspicion that it may prove to be only a casual mutation of *C. Sayana.* The shell figured under this name by Tuomey and Holmes appears to be something else.

Genus **PITARIA** Römer (em.).

Pitar Römer, Krit. Unters., p. 15, 1857; Malak. Blätt., ix., p. 58, 1862 (olim); Meek, Pal. Upper Missouri, p. 179, 1876; Bucquoy, Dautzenberg, and Dollfus, Moll. Roussillon, ii., p. 329, 1893. Type *Venus tumens* Gmelin (+ *Cytherea striata* Sowerby).

<*Caryatis* Römer, Mal. Blätt., ix., p. 58, 1862; Mon. *Venus,* i., p. 79, 1867; Stoliczka, Cret. Pel. India, p. 151, 1871; Tryon, Syst. Conch., iii., p. 178, 1884; not *Caryatis* Hübner, *Lepidoptera,* 1816.

>*Dione* Gray, P. Z. S., 1847, p. 183 (*Venus dione* Linné); Deshayes, Cat. Conch. Brit. Mus., p. 55, 1853; Römer, Krit. Unters., p. 15, 1857; Mon. *Venus,* i., p. 127, 1868; Stoliczka, Cret. Pel. India, p. 151, 1871; Meek, Pal. Upper Missouri, p. 178, 1876; Tryon, Syst. Conch., iii., p. 178, 1884; not *Dione* Gray, 1851, or Hübner, 1816.

>*Venus* Megerle von Mühlfeld, Mag. Ges. Naturf. Freunde zu Berlin, v., p. 15, 1811 (*Venus dione* Linné); not *Venus* Lamarck, 1799.

>*Hysteroconcha* Fischer, Man. de Conchyl., p. 1079 (in synonymy), 1887; *Venus dione* Linné.

>*Tivelina* Cossmann, Cat. Illustré bas. Paris, i., p. 107, 1886 (*Cytherea tellinaria* Deshayes); Fischer, Man. de Conchyl., p. 1080, 1887.

Pitaria Dall, Proc. U. S. Nat. Mus., xxvi., No. 1312, p. 353, 1902.

Römer in 1857 used an unmodified African vernacular name, taken from Adanson, for this genus, but, later, realizing that this was not authorized by the rules of nomenclature, attempted to substitute for it the name *Caryatis,* which had already been used in entomology. If it is decided that vernacular names should be excluded (and why should we use one from a negro dialect any more than from English or French?), it will be probably best to give a Latin form to Römer's name, as has been done with many of Adanson's, and call the group *Pitaria.* It may be divided as follows:

Section *Pitaria* s. s. Type *Venus tumens* Gmelin.

Shell subtrigonal or ovate, convex, solid, smooth or concentrically sulcate or waved; pallial sinus ample, deep, reaching the middle of the shell, moderately ascending; hinge with a well-developed anterior lateral, the posterior cardinals often grooved; lunule not deeply impressed, bounded by an incised line, escutcheon not limited or well defined; internal margins entire, smooth.

This group includes the majority of the so-called *Cythereas,* which have a subtrigonal solid shell, unpolished, with an inconspicuous periostracum and concentric sculpture of lines, wrinkles, small waves or sulci, not raised into lamellæ or distally elevated. They are nearly all tropical and largely Oriental shells.

Section *Hyphantosoma* Dall, 1902. Type *Cytherea carbasea* Guppy, 1866. Oligocene of Jamaica.

Surface with fine zigzag sculpture as in *Textivenus* of the Venerine series, otherwise as in *Pitaria.*

Section *Tivelina* Cossmann. Type *Cytherea tellinaria* Lamarck. Eocene.

Shell pointed behind, with a Tellina-like twist to the valves, which are concentrically striate; hinge as in *Chionella;* pallial sinus short, bluntly rounded.

Subgenus HYSTEROCONCHA Fischer.

Shell subtrigonal, plump, concentrically laminate; lunule and escutcheon situated in an impressed area and defined by a deeply incised line; laminæ spinose near the boundary of the posterior area; coloration tinted, not in patterns; inner margins smooth; pallial sinus linguiform, ample, free, slightly ascending; hinge as in *Pitaria,* the edges of the nymphs finely granular, and the stout middle cardinal sometimes obscurely channelled. Habitat tropical American seas. Type *Venus dione* Linné.

The animal of this species and of *Mactra* and some other bivalves was called *Callista* by Poli, but the name was not used in binomial nomenclature until 1852. The group is *Dione* Gray, 1847, not Gray, 1851, nor Hübner, 1816; and *Venus* Megerle, 1811, not of Lamarck, 1799. Fischer cites *Hysteroconcha* in synonymy from Lang, who was nonbinomial.

Section *Lamelliconcha* Dall, 1902.

Shell trigonal, subcompressed, concentrically ribbed or laminate, without spines, the escutcheon not defined, the edges of the nymphs smooth, otherwise like *Hysteroconcha*. Type *Cytherea concinna* Sowerby.

Seas of the tropics, especially west America.

Cytherea perbrevis Conrad, 1848, from the Vicksburgian, is a *Pitaria* and is as a rule more elongate and ovate-trigonal than would be supposed from Conrad's figure, which represents an unusually short specimen. *Meretrix sapotensis* Gabb, 1881, from the Oligocene of Costa Rica, and *Caryatis Guppyana* Gabb, from the Pliocene clays of Costa Rica, near Moen, also belong to this group. *Circe* (*Lioconcha*) *Newcombiana* Gabb, from the Pleistocene of San Diego, California, and living on the same coast, may also be referred to *Pitaria*.

Pitaria (**Hyphantosoma**) **carbasea** Guppy.

Cytherea (*Circe*) *carbasea* Guppy, Quart. Journ. Geol. Soc. Lond., xxii., p. 292, pl. xviii., fig. 13, 1866.

Callista carbasea Gabb, Geol. Rep. St. Domingo, p. 250, 1873.

Oligocene marl of Bowden, Jamaica; Vendryes, Henderson, and Simpson.

The peculiarity of this species, apart from its thin shell, recalling *Callocardia*, is the fine, sharp, divaricate sculpture. In the Chipola species, about to be described, the sculpture is still obvious, but its sharpness and clear definition are gone; in the Pliocene species the divarication may be observed by close scrutiny on certain portions of the disk, but is absent elsewhere, and in some fresh specimens can hardly be distinguished, and, finally, in the recent *Pitaria Simpsoni* Dall, of the Antilles, no trace of such structure remains on the surface. But let the shell be weathered and acted on by erosion and the intrinsically divaricate nature of the shell structure stands revealed. There seems to be a difference in endurance between the sulci and the ridges in such a shell, with the consequence that under the action of water and carbonic acid the little punctures due to erosion arrange themselves in divaricate lines, revealing structure otherwise invisible.

Pitaria (Hyphantosoma) floridana n. sp.

PLATE 54, FIGURE 10.

Oligocene marl of the Chipola horizon at Alum Bluff and on the Chipola River at McDonald's farm; Dall and Burns.

Shell subtrigonal, solid, nearly equilateral, sculptured with fine, close, concentric wrinkles, over and upon which is imposed the faint, close, zigzag sculpture of divaricate lines with numerous angles; anterior dorsal slope nearly straight, posterior gently arched, with one or two faint radial ridges indicated as extending from the umbo to the posterior margin; lunule long, rather narrow; hinge delicate, anterior lateral prominent, compressed; posterior right cardinal bifid near the dorsal end; grooves of the dorsal margin deep; anterior end rounded; posterior end obscurely truncate, base produced a little in the middle. Length 29.2, height 24.0, diameter 17.0 mm.

Young shells were abundant in the marl, full-grown ones comparatively scarce.

Pitaria (Hyphantosoma) opisthogrammata n. s.

PLATE 54, FIGURE 8.

Pliocene marl of Shell Creek and Alligator Creek, near Charlotte Harbor, Florida; Willcox and Burns.

Shell rounded quadrate, produced and attenuated in front, subtruncate behind, with a well-marked, wide, shallow sulcus extending from the beaks backward and downward to the middle of the truncation; beaks inflated, anteriorly twisted; lunule deeply impressed, subcordate, defined by a sharply incised line, with a second impressed but less conspicuous and regular line in harmony with the lunular boundary and dividing the lunule into two subequal parts; surface concentrically striate, feebly on the middle of the disk and more emphatically towards the ends of the shell; the zigzag sculpture nearly obsolete but usually discernible on the smoother basal parts of the shell, and stronger in some specimens than in others; pallial sinus ample, linguiform, reaching the middle of the shell, with the upper border nearly on a level with the bases of the adductor scars; the hinge well developed, the anterior lateral prominent, compressed, triagular. Length 39, height 32, diameter 22 mm.

The impressed lunule is more conspicuously depressed in the adult than in the partly grown shell and differs also in different specimens.

Pitaria (Lamelliconcha) imitabilis Conrad.

Cytherea imitabilis Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 292, 1848; Journ. Acad. Nat. Sci. Phila., 2d Ser., i., p. 123, pl. xiii., fig. 14, 1848.

Dione imitabilis Conrad, Am. Journ. Conch., i., p. 6, 1865; Checkl. Eoc. Fos., p. 28, 1866.

Lower Oligocene of Vicksburg, Mississippi, in both upper and lower beds; of Johnson's sink, Levy County, and Martin Station, Marion County, Florida; Willcox.

A very characteristic Vicksburgian species.

Pitaria (Lamelliconcha) planivieta Guppy.

Cytherea (Callista) planivieta Guppy, Quart. Journ. Geol. Soc. Lond., xxii., p. 292, pl. xviii., fig. 3, 1866.

Callista planivieta Gabb, Geol. St. Domingo, p. 250, 1873.

Oligocene of the Bowden marl, Jamaica, and of St. Domingo, Guppy and Gabb; of White Beach, near Osprey, Florida, Dall.

This identification is probable but not absolute, as the White Beach fossils are pseudomorphs in rather imperfect preservation.

Pitaria (Lamelliconcha) Hillii n. sp.

Plate 54, Figure 7.

Oligocene of the vicinity of Gatun on the line of the Panama Canal, Colombia.

Shell elongated, moderately convex, ovate, inequilateral, the beaks within the anterior third, moderately prominent; lunule small, impressed, lanceolate; surface sculptured with narrow, low, roundish ribs with narrower deep sulci between them; an obscure ridge extends from the beaks to the lower posterior margin, which it almost angulates; anterior end rounded, base gently arcuate; posterior end blunt rather than truncate; hinge obscured by the matrix; pallial sinus deep, reaching beyond the middle line of the shell, rather narrow. Length about 36, height 22, diameter 13 mm.

This has somewhat the aspect of a *Paphia,* but until the hinge is better known in all probability it will be most suitably placed here. A larger, somewhat rudely concentrically striated species also occurs in the same beds but is represented by such inadequate material in our collection that I refrain from attempting to describe or name it.

The preceding species have been placed under *Pitaria* in *Lamelliconcha,* though in some respects they seem more nearly related to *Macrocallista.* I am

not at all sure that it might not accord better with the true relationship to propose another section under *Macrocallista* for sulcate species and put these shells there. Those which follow are typical or at least are apparently more closely related to *Pitaria* than to anything else.

Pitaria (Lamelliconcha) circinata Born.

Venus circinata Born, Test. Mus. Vind., p. 61, pl. iv., fig. 8, 1780; Dillwyn, Descr. Cat. Rec. Shells, i., p. 169, 1817.

Venus rubra Gmelin, Syst. Nat., vi., p. 3288, 1792.

Tellina senegalensis Gmelin, *op. cit.*, p. 3244; Wood, Gen. Conch., p. 199, 1815.

Venus rubescens Solander, MS., *fide* Dillwyn, Desc. Cat. Rec. Shells, i., p. 169.

Cytherea juncea Guppy, Quart. Journ. Geol. Soc. London, xxii., p. 582, pl. xxii., fig. 13, 1866.

Chione circinata Gabb, Geol. St. Dom., p. 250, 1873.

Cytherea alternata Broderip, P. Z. S., 1835, p. 45.

Dione circinata Deshayes, Cat. Conch. Brit. Mus., p. 77, 1853.

Oligocene of Gatun, on the line of the Panama Canal, Colombia, R. T. Hill; of Cumana, Venezuela, Guppy; Pliocene of Trinidad, West Indies, Guppy; living on both coasts of Central America and in the Antilles.

Gabb was mistaken in doubting Reeve's location of this species at Mazatlan. It is one of the very small number of *Veneridæ* which occur on both the Atlantic and Pacific coasts of middle America, and in harmony with this exceptional distribution also occurs in the Isthmian Oligocene. I have compared Guppy's type with the recent shell and find only the difference that the hinge is more solid and heavy in the fossil, but such differences also occur between recent specimens, and I am therefore driven to the conclusion that, so far as the material at my disposition goes, there is no specific distinction to be drawn between the recent and the Oligocene shells, a conclusion earlier reached by Gabb, who was, however, rather given to inadvisable consolidations.

Pitaria (Lamelliconcha) astartiformis Conrad.

Cytherea astartiformis Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 292, 1848; Journ. Acad. Nat. Sci. Phila., 2d Ser., i., p. 123, pl. xiii., fig. 13, 1848.

Dione astartiformis Conrad, Am. Journ. Conch., i., p. 6, 1865; Checkl. Eoc. Fos. N. Am., p. 28, 1866.

Lower Oligocene at Vicksburg, Mississippi; upper Oligocene of the Chipola beds at Alum Bluff and on the Chipola River, Calhoun County, Florida; Burns and Dall.

This is a well-characterized and interesting species. The lunule is defined only by a feebly incised line which is often indistinguishable in partly worn specimens. The hinge is massive for the size of the shell, the pallial sinus angular and nearly horizontal, and the basal margins entire. The concentric sculpture is low and rounded over the greater part of the disk, becoming higher and sharper near the posterior end of the shell. The specimens I have seen from Vicksburg are from the clay bed and not the marl, and I do not know whether they also occur in the marl or not.

Pitaria (Lamelliconcha) calcanea n. sp.

Plate 55, Figure 19.

Oligocene of Vicksburg, Mississippi; Johnson and Crutcher.

Shell small, solid, subtrigonal, elevated, with prominent anteriorly twisted beaks; lunule impressed, obscurely limited by an impressed line, rather large, cordate; an obscure ridge extends from the beaks backward and downward to the lower posterior end of the shell; anterior end attenuated, rounded; posterior end broader and more bluntly rounded; base arcuate; sculpture of thick, adjacent, low, rounded concentric ribs, smooth except for the ribbing; when partly eroded showing fine, thread-like, concentric structure; nymphs short; hinge solid, concentrated, the teeth entire, the posterior left cardinal slender, the anterior lateral stout and prominent; internal margins entire; pallial sinus linguiform, slightly ascending, not reaching the middle of the shell. Length 17, height 15, diameter 10 mm.

This shell is somewhat rude and individuals differ somewhat in form, but all show the elevated and twisted beaks and the broad, low, thick ribs, differing from *P. astartiformis,* which has narrow ribs terminally acute, separated by deep channels.

Pitaria (Lamelliconcha) filosina n. sp.

Plate 57, Figure 1.

Upper Miocene of North Carolina at the Natural Well in Duplin County; Burns.

Shell small, subcompressed, ovate-trigonal, with low, small, pointed beaks; lunule large, lanceolate, hardly differentiated from the rest of the surface by an obscure impressed line, the surface of the lunule sculptured like the rest of the shell and not impressed; surface with very fine, close, thread-like concentric ribs but no radial sculpture: hinge well developed but delicate: the anterior right, the posterior and anterior left cardinals entire, the others grooved or

bifid; the anterior lateral inconspicuous; the anterior left and posterior right dorsal margins grooved to receive the edge of the opposite valve, the basal margins entire; the pallial sinus large, linguiform, ascending towards the umbo. Length 7.75, height 7.5, diameter 4.0 mm.

This odd little shell recalls *Gouldia* by its form and *Dosinia* by its sinus. Nothing very close to it in the Miocene has turned up.

Genus **CYTHEREA** Bolten.

<*Cytherea* Bolten, Mus. Boltenianum, p. 177, 1798; ed. ii., p. 124, 1819; not *Cytherea* Fabricius (*Diptera*), 1804, or Oken, 1815; *Citherea* Lamarck in Roissy, 1805; *Cytherea* Lamarck, 1806; or H. and A. Adams, Gen. Rec. Moll., ii., p. 660, 1858. Types (by elimination) *Venus puerpera* L., *V. rugosa* Gmelin, and *V. verrucosa* L.

Gafrarium (*sp.*) Bolten, Mus. Boltenianum, p. 176, 1798; ed. ii., p. 123, 1819; *Venus reticulata* Linné.

Venusarius Dumeril (Froriep's translation), Zool. Analyt., p. 169, 1806; *Venus verrucosa* Linné.

>*Antigona* Schumacher, Essai, pp. 51, 154, 1817; sole ex. *A. lamellaris* Schum., *loc. cit.*, pl. xiv., fig. 2, = *Dosina lamarckii* Gray, 1838; not *Antigonus* Hübner, *Lepidoptera*, 1816.

>*Cythereites* Krüger, Gesch. der Urwelt, ii., p. 449, 1823; *C. rugosus* Krüger.

Dosina Gray, Analyst, viii., p. 308, 1838, no type selected; P. Z. S., 1847, p. 183; *Venus verrucosa* L.; not *Dosinia* Scopoli, 1777.

Clausina Brown, Ill. Conch. Gt. Brit., expl. pls. xix., xx., 1827; ed. ii., pp. 90–91, 1844; Gray, P. Z. S., 1847, p. 183; *Venus verrucosa* Linné; not *Clausina* Römer, Krit. Unters., p. 16, 1857 (*V. tiara* Dillw.).

Omphaloclathrum Mörch, Cat. Yoldi, ii., p. 25, 1853; Römer, Mal. Blätt., xiv., p. 29, 1867; Fischer, Man. de Conchyl., p. 1084, 1887.

Venus Swainson, Malac., p. 372, fig. 119c, 1840; *Venus verrucosa* L.; H. and A. Adams, Gen. Rec. Moll., ii., p. 417, 1857; Deshayes, Cat. Conch. Brit. Mus., i., p. 97, 1853; Stoliczka, Cret. Pel. India, p. 147, 1871; not *Venus* (L.) Lamarck, 1799.

Calista Leach, Syn. Moll. Gt. Brit., p. 305, 1852; *V. verrucosa* Linné; not *Callista* Mörch, 1853.

Callista Fischer, Man. de Conchyl., p. 1084, 1887; *V. verrucosa* Linné; not of Mörch, 1853.

>*Ventricola* Römer, Mal. Blätt., xiv., p. 115, 1867, 1st species *V. rugosa* Gmelin, no type selected; Sacco, Moll. terz. Piem. e Lig., p. 27, 1900.

Cytherea Dall, Proc. U. S. Nat. Mus., xxvi., No. 1312, p. 354, 1902.

>*Antigona* Römer, Krit. Unters., p. 17, 1857, *V. puerpera* L.

>*Artena* Conrad, Am. Journ. Conch., vi., p. 76, 1870, *Venus staminea* Conrad; Fischer, Man. de Conchyl., p. 1084, 1887.

>*Artenia* Tryon, Syst. Conch., iii., p. 178, 1884; = *Artena* Conrad.

Cytherea verrucosa has the siphons short, but mostly free from each other, their orifices and the mantle margin fringed, and the foot geniculate.

This genus is divisible into two groups or subgenera as follows:

Genus *Cytherea* Bolten. Type *Venus puerpera* L. Dental formula $\frac{L.\ 0.1010101.1}{R.\ 0.0101010.0}$.

Shell large and rotund, valves convex, with strong sculpture in which the concentric element predominates, with well-marked lunule and escutcheon, the latter unequally divided between the valves, larger in the left valve; umbones plump; ligament set in a groove; cardinals large, the middle left and the posterior two right cardinals bifid, the left anterior lateral papilliform, obscure, sometimes obsolete; pallial line with a small, short, rounded sinus; inner margins of the valves crenulate.

Subgenus *Cytherea* s. s.

Shell large, reticulately sculptured; the portion of the escutcheon in the right valve (when not defective) forming a thin lamina which projects over the sunken ligament and almost completely hides it; pallial sinus wide, short, and rather rounded in front; lateral tooth minute or obsolete.

Section *Clausina* Brown.* Type *V. verrucosa* Linné.

Shell large, strongly concentrically lamellose with obscure divaricating radials towards the ends; right portion of the escutcheon slightly overlapping behind but not over the ligament; pallial sinus small, narrow, angular.

Section *Ventricola* Römer. Type *V. rugosa* Gmelin.

Shell large with strong, recurved, concentric lamellæ regularly spaced, between which are smaller concentric threads; pallial sinus small, angular; lunule deeply impressed.

Subgenus APHRODINA Conrad.

Aphrodina Conrad, Am. Journ. Conch., iv., p. 246, 1868 (*Meretrix tippana* Conrad); Kerr, Geol. Rep. N. Car., App., p. 7, 1875; Meek, Pal. Upper Missouri, p. 179, 1876; Tryon, Syst. Conch., iii., p. 177, 1884.

Shell concentrically striated, with a circumscribed lunule, but no defined escutcheon; inner margins smooth; pallial sinus ample, free, ascending, rather rounded in front; hinge with three cardinals in each valve, the right posterior

* The name *Venusarius* of Dumeril is older, but was given to the animal alone, under a non-Linnean system of nomenclature.

cardinal bifid; an elongate anterior lateral corrugated on both sides and received into a corrugated pit in the right valve; nymphs plain.

This form, while less orbicular, recalls *Dosiniopsis* and *Cyclorisma* by its characters, differing from the former by the absence of granulations on the nymphs and of a posterior lateral tooth, and from the latter by the presence of a defined lunule and an anterior lateral tooth.

It is a member of the upper Cretaceous fauna of the southeastern United States.

Subgenus ANTIGONA Schumacher.

Type *Cytherea lamellaris* Schumacher (*Dosina lamarckii* Gray).

Shell smaller and more trigonal, less rotund than *Cytherea* s. s.; the left anterior lateral lamelliform and larger, with a perceptible socket in the right valve; the posterior right cardinal broad and deeply bifid; pallial sinus small, triangular.

Section *Antigona* s. s.

Shell rather elongate, with profuse concentric lamellæ crenulated by fine radial ribs; the lunule deeply impressed, the ligament exposed, the overlap of the escutcheon small.

Section *Artena* Conrad.

Shell trigonal or short, with acute concentric laminæ, between which are minute elevated concentric lines; lunule not deep; escutcheon large, not overlapping; posterior right cardinal narrow; anterior left lateral compressed, narrow, laminar; other features as in *Antigona*.

This section bears to *Antigona* much such a relation as *Ventricola* does to typical *Cytherea* in the other subgenus.

Subgenus CIRCOMPHALUS Mörch.

Circomphalus (sp.) Herrmannsen, Ind. gen. Mal., i., p. 237, 1847; Mörch, Cat. Yoldi, p. 23, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 422, 1857. No type selected.

Circumphalus Tryon, Syst. Conch., iii., p. 176, 1884; *V. plicata* Gmelin (= *V. dysera* Linné, *pro parte*).

Anaitis Tryon, Syst. Conch., iii., p. 177, 1884; not of Duponchel, *Lepidoptera*, 1829, nor of Römer, 1857 (*ex parte*).

Chiona Römer, Krit. Unters., p. 16, 1857; not of Mörch, Cat. Yoldi, p. 24, 1853.

Shell cordate, compressed, with distant elevated reflected laminæ, more or less phyllate near the escutcheon; lunule and escutcheon impressed, sharply

limited, striated, unequally divided between the valves, smaller in the right valve; the right portion of the escutcheon somewhat overlapping but not hiding the deeply sunken ligament; inner margins finely crenate; pallial sinus small, triangular; anterior right and posterior left cardinals slender, laminar, entire, the others grooved or bifid, a minute pustular anterior lateral present in the left valve. Type *Venus plicata* Gmelin.

The minute lateral has generally been overlooked and the shell associated with *Chione,* from which it also differs by the character of its sculpture.

Subgenus LEPIDOCARDIA Dall.

Lepidocardia Dall, Proc. U. S. Nat. Mus., xxvi., No. 1312, p. 356, 1902.

Shell small, compressed, rounded and short in front, elongated and pointed behind, smooth or concentrically striated, polished, with delicate coloration; lunule narrow, circumscribed, but no defined escutcheon; internal margins smooth; pallial sinus linguiform, horizontally extended, pointed in front, partly confluent with the pallial line below; anterior left and posterior right dorsal margins beyond the hinge-plate grooved to receive the edge of the opposite valve; teeth delicate, anterior laterals well developed; posterior right and two anterior left cardinals more or less distinctly grooved.

Type *Chione floridella* Gray (1838) + *Venus africana* Philippi, 1843. Africa.

This group recalls *Gomphina* in its general appearance, though much less inflated. The species have been referred to several unrelated groups. The coloration is extremely variable and is not excelled in beauty by any of the *Veneridæ.*

The *Cytherea semipunctata* figured (plate xiii., fig. 19) but not described by Conrad, in his memoir on the fossils of the Vicksburgian, of 1848, I have not found any other reference to. It may be a *Gouldia* or a small species of *Pitaria.*

Cytherea tarquinia Dall.

PLATE 38, FIGURES 2, 2a.

Venus magnifica Heilprin, Trans. Wagner Inst., i., p. 116, 1886; not of Sowerby, 1853.
Venus tarquinia Dall, Trans. Wagner Inst., iii., p. 1194, pl. xxxviii., figs. 2, 2a, 1900.

Oligocene of the Tampa silex beds at Ballast Point, Tampa Bay, Florida, Willcox and Dall; St. Domingo, Gabb.

Shell short-ovate, moderately convex, with low, inconspicuous beaks; sculptured with numerous even, regular, thread-like radial riblets, separated by

narrower interspaces, and with rather distant, slightly elevated, thin crenulate concentric lamellæ; lunule lanceolate, small and narrow; escutcheon defined by a deep sulcus, on the left valve almost linear, on the right wider but usually defective in the fossils; hinge normal, anterior lateral small and pustular; pallial sinus small, short, ascending, rounded in front; basal inner margin minutely crenulate. Length 49, height 41, diameter 26 mm.

This species, though similar in a general way to the young of the large species like *C. Listeri* Gray, of which it is the precursor, never attains a large size, the measurements given being taken from a fully adult specimen. It is not uncommon at Ballast Point and is chiefly notable for the regularity of its radial sculpture and the thin and distant concentric lamellæ.

Cytherea cæsarina n. sp.

PLATE 53, FIGURE 5.

Oligocene of the Chipola marl, Calhoun County, Florida, Burns; and of White Beach near Osprey, Florida, Dall.

Shell ovate, inequilateral, the beaks being in or at the anterior fourth lunule; hardly impressed, concentrically striate, cordate, small; escutcheon long and narrow, wider in the right valve, bordered on each valve with a strong sulcus, the ligament hidden by the right-hand portion; sculpture of numerous narrow, elevated, thickened, concentric lamellæ, somewhat reflected and with narrower concentrically striate interspaces; these cross fine radial riblets, which are distinct and uniform on the young shell but rapidly become obsolete, though the broad tops of the concentric sculpture are crenulate or, more strictly speaking, articulated by the development on them of channels or sulci corresponding to those of the obsolete riblets; hinge strong, the larger cardinals deeply bifid, the anterior lateral small and pustular; pallial sinus small, ample, short, rounded in front; inner basal margins minutely crenulate. Length of figured valve 66, height 58, double diameter 40 mm.; length of an internal cast from White Beach 75, height 60, diameter 42 mm.

This fine species is quite distinct from any of the others; the radial sculpture, contrary to usage, is more distinct in the middle of the disk than on the distal portions of the shell. It much more nearly resembles the recent west American *C. multicostata* Sowerby than any species now living on the Atlantic side, and adds in this way an interesting item to the list of those which indicate more or less clearly a tolerably close connection between the two faunas in Oligocene times.

Cytherea Willcoxi n. sp.

PLATE 53, FIGURE 3.

Pliocene marl of the Caloosahatchie River, near the site of old Fort Thompson; Willcox and Dall.

Shell large, capacious, with well-rounded, somewhat anteriorly twisted beaks; a cordate lunule unequally divided and larger in the right valve; escutcheon long, bordered by a wide, shallow sulcus more emphatic in the left valve; sculpture of very numerous concentric lamellæ widened and flattened at the top so that they nearly (and sometimes quite) join over the interspaces, especially towards the base; these lamellæ, though sharper distally, do not rise into wide, thin laminæ, as in the well-developed individuals of *C. Listeri*, but remain of nearly the same height over the whole shell; near the beaks fine radial striation is notable in the interspaces, faintly crenulating the concentric lamellæ but becoming almost wholly obsolete as the shell approaches maturity; hinge solid, the two posterior cardinals in each valve deeply bifid; the anterior lateral reduced to a low pustule; inner margins minutely crenulate; adductor scars very large; pallial sinus ample, linguiform, rising above a line joining the bases of the scars. Length 102, height 87, diameter 60 mm.

Shell somewhat resembling the recent *C. Listeri* Gray of the Florida Keys, but differing from it by larger size, much closer and more uniform concentric lamellation, proportionally larger lunule and escutcheon, heavier hinge, proportionately larger adductor scars, and more ascending pallial sinus.

I take great pleasure in naming this splendid shell after Mr. Joseph Willcox, to whom we are indebted for so much in connection with the explorations of the Pliocene and Oligocene of Florida, and for the discovery of this and many other of their finest fossil remains.

Cytherea (Ventricola) ucuttana n. sp.

PLATE 57, FIGURE 14.

Red Bluff horizon of the lower Oligocene of Mississippi on Ucutta Creek, Clarke County, Carson's Creek, and at Red Bluff, Wayne County; Johnson, Burns, and others.

Shell small, moderately convex, rotund, with low, inconspicuous, prosogyrate beaks; lunule small, slightly impressed, bounded by an impressed line; escutcheon very narrow, defined by a radial ridge sharper in the left valve; surface sculptured with numerous low, even, gently rounded, wavelike concentric ridges and by fine, close, regular, low concentric threads which cover the whole surface; hinge solid, normal, well developed, the anterior lateral

distinct; inner margins, except the posterior margin, finely crenulate; pallial sinus very small, triangular; outer edges of the adductor scars usually a little raised. Length 19.0, height 16.5, diameter 8.0 mm.

This neat little shell grows to a somewhat larger size, as fragments indicating individuals one-third larger than the measurements given are in the collection. It is from this stem that the upper Oligocene and Miocene *Artena* seems to be derived.

Cytherea (Ventricola) Blandiana Guppy.

Venus Blandiana Guppy, Geol. Mag., Decade ii., vol. i., p. 444, pl. xvii., fig 8, 1874.

Oligocene of Bowden, Jamaica, Vendryes, Henderson, and Simpson; of Haiti, Guppy; of Florida at White Beach, near Osprey, and the Chipola beds on the Chipola River, Calhoun County, and of Curaçoa, Dutch West Indies.

This species recalls *C. strigillina* Dall, of the recent West Indian fauna, but has the primary concentric lamellæ lower and more distant, the secondary sculpture more distinct, and a more elongated outline. The young shells are more rounded than the adults.

Cytherea (Ventricola) rugatina Heilprin.

Venus rugatina Heilprin, Trans. Wagner Inst., i., p. 92, pl. xi., fig. 24, 1887; Dall and Simpson, Moll. of Porto Rico, p. 483, 1901.

Pliocene beds of the Caloosahatchie River and Shell Creek, south Florida, Willcox, Dall, and Burns; living from Cape Hatteras, North Carolina, to the Florida Keys, and at Mayaguez, Porto Rico, West Indies, United States Fish Commission.

This fine shell is well distinguished from *C. rugosa,* as Heilprin has shown. The recent specimens found are all young or adolescent, but agree well with the fossil individuals of the same size.

Cytherea (Artena) glyptoconcha n. sp.

PLATE 55, FIGURE 24.

Cytherea staminea Heilprin, Trans. Wagner Inst., i., p. 116, 1887; not of Conrad, 1839.

Oligocene of the silex beds at Ballast Point, Tampa Bay, Florida; Willcox, Burns, and Dall.

Shell variable in form from short to rather produced, trigonal with the posterior slope longer and the posterior end subrostrate; beaks (normally) pointed, moderately high, subcentral; lunule cordate, striated, impressed; an-

terior end below the lunule rounded; posterior slope nearly straight; a striated narrow area representing the escutcheon is bounded by a rapidly widening radial ridge, in front of which is a shallow sulcus, the whole forming at its intersection with the posterior border a short rostrum; sculpture of heavy, slightly recurved concentric ribs, somewhat expanded on the rostrum and covered with a fine secondary close, concentric striation; base arcuate; hinge heavy, normal, the anterior lateral small but distinct; basal margin minutely crenulate; pallial sinus small, triangular. Dimensions of varying forms:

Elongate	length	22.0,	height	15.0,	diameter	11.0 mm.
Normal	"	26.5,	"	20.5,	"	18.0 mm.
Short	"	18.0,	"	16.5,	"	13.0 mm.

A few specimens show faint radial striation on the ventral side of the ribs nearest the base of the shell.

This interesting species has the general aspect of *Lirophora,* the minute sculpture and hinge of *Artena.* It is one of the more abundant species in the silex beds.

Cytherea (Artena) Shepardi n. sp.

PLATE 55, FIGURE 16.

Oligocene of Hillsboro' Bay and Ballast Point, near Tampa, Florida; J. Shepard, Willcox, Post, and Dall.

Shell small, solid, subtrigonal, concentrically feebly waved, the waves more distinct near the beaks, the whole surface minutely, closely, concentrically striated; lunule narrow, lanceolate, defined by a sharply incised line, but feebly impressed; escutcheon narrow, striated, defined by a sharp radial keel beyond which the concentric waves do not pass; beaks small, pointed, prosogyrate; hinge normal, anterior lateral well developed; inner margins finely crenulate; pallial sinus small, triangular. Length 21.0, height 18.5, diameter 12.0 mm.

This species recalls *C. ucuttana* in its sculpture, but it has the *Chione*-shape of *Artena* and an almost rostrate posterior end. It is nearest to *C. glyptoconcha,* but is less produced and wants the prominent ribbing.

Cytherea (Artena) undulata Conrad.

Artena undulata Conrad, Am. Journ. Conch., vi., p. 76, 1870. Cf. Dall, Am. Journ. Sci., 3d Ser., xlviii., pp. 300–301, 1894.

From the phosphatic rock of the Ashley River, South Carolina, the upper or Miocene member of the Ashley and Cooper marls of Tuomey.

This is a very distinct species, rounded trigonal when young; the older specimens grow faster ventrally than distally, making the form high and short; the surface is covered with fine concentric threads close set, and has in the middle of the disk a few faint undulations. The deep and prominent undulations visible on many of the casts taken from the rock seem to be due to erosion or decay before fossilization; the lunule is cordate and sharply limited by an incised line. The beaks rise high above the hinge, which is normal with a well-developed anterior lateral. The margin of the valves forms a subcircular outline, minutely crenulate. A well-grown specimen measures, length 18, height 21, diameter 18 mm.

Cytherea (Artena) staminea Conrad.

Cytherea staminea Conrad, Fos. Medial Tert., cover of No. 1, 1839, pl. xxi., fig. 1.

Artena staminea Conrad, Am. Journ. Conch., vi., p. 76, 1870; not of Heilprin, Trans. Wagner Inst., i., p. 120, 1887.

Venus staminea Conrad, Bull. Nat. Inst., ii., p. 183, 1842; not of Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 250, pl. xix., fig. 14, 1837 (= *Protothaca* sp.).

Miocene of Calvert Cliffs, Plum Point, St. Mary's River, and other localities in Maryland.

A characteristic Miocene shell, notable for its inflated form and sharp, recurved, concentric ribs. The escutcheon is very large and bounded on each side by a strong radial keel.

Other species which have been referred to the genus *Cytherea* are *C. elevata* H. C. Lea, 1845, from the Miocene of Petersburg, Virginia, a minute shell less than eight millimetres long; another *C. elevata* from the Miocene of Florida was listed by Conrad in 1846, but not described or figured. *C. mississippiensis* Conrad, from the Vicksburgian, was afterwards referred by him to *Chione*. *C. nuciformis* Heilprin is a species of *Chione*. *C. semipunctata,* figured and named, but not described, by Conrad, from the Vicksburgian in 1848, does not appear elsewhere, as far as I can discover, in the literature. *C. sobrina* Conrad from the same horizon is a *Chionella*. *C. multicostata* Sby. has been enumerated as one of the reef Pleistocene fossils of St. Domingo, but doubtless through a misidentification, perhaps of *C. Listeri* Gray, which is known to occur in these beds. *Callista acuticostata* and *C. Tryoniana* Gabb, 1873, from the Oligocene of St. Domingo, are referred by Guppy to *C. circinata* Born. *Caryatis Lordleyi* Gabb, 1881, from the Pliocene of Costa Rica, is unfigured. The *C. Guppyana* described at the same time is perhaps a *Chionella*.

Genus **SAXIDOMUS** Conrad.

Saxidomus Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 249, 1837; *S. Nuttallii* Conrad; H. and A. Adams, Gen. Rec. Moll., ii., p. 437, 1857; Carpenter, P. Z. S., 1856, p. 215; Rep. Brit. Assoc. for 1856, p. 192 *et seq.*, 1857; Suppl. Rep. Brit. Assoc. for 1863, p. 641, 1864; Gabb, Pal. Cal., ii., pp. 58, 98, 1869; Dunker, Ind. Moll. Mar. Japon., p. 208, 1182; Tryon, Syst. Conch., iii., p. 175, 1884; Fischer, Man. de Conchyl., p. 1086, 1887.

Venus (sp.) Philippi, Abb. und Beschr., ii., p. 151, 1846.

Tapes (sp.) Gould, Rep. Pac. R. R. Expl., v., p. 333, 1856.

Saxidomus (pars) Deshayes, Cat. Conch. Brit. Mus., i., p. 186, 1853 (*Tapes* sp. *exclus.*).

This genus has never been correctly described or clearly understood. The animal has long, large siphons closely united nearly to their orifices, which have inconspicuously papillose openings; the margin of the mantle is slightly festooned rather than fringed; the foot is very large, triangular, with no "heel," but with a compressed thin margination; there are four rather large plicate palpi; the gills are normal, rounded in front and behind, the leaves subequal, and rather small for the size of the animal; the mantle is open ventrally, as in most *Veneridæ*. In harmony with these *Meretricinæ* characters we find the dental formula, when correctly stated, to be $\frac{\text{L. } 101010.010}{\text{R. } 010101.101}$. The teeth are much concentrated, so that the left anterior lateral has the appearance of being one of the cardinal series and the anterior right cardinal is frequently in line with the adjacent lateral, so that they have been taken to be one and the same tooth. The posterior right cardinal is deeply bifid, the other teeth are entire and smooth. The ligament is long, strong, and wholly external. There is no circumscribed or impressed lunular area or escutcheon. The internal margins of the valves are smooth, the pallial line with a deep, nearly horizontal sinus, rounded in front. The external sculpture is wholly concentric, though the ridges of the rougher species sometimes inosculate. The radially sulcate series (*Saxidomus* II.) of Deshayes contains only species of *Protothaca*. The genus reaches back to the Eocene in time, the species are distributed on the Asiatic and American shores of the Pacific, and their metropolis is on the west coast of America.

Saxidomus Nuttallii Conrad, 1837, was an adolescent specimen of the species described by Gould in 1861 as *S. aratus*, and by Philippi in 1846 as *Venus maximus* (Anton MS.). The very young smooth stage was named *Tapes gracilis* by Gould in 1855. It has in the adult state a concentrically more or less sulcate surface and one or more purple patches on the dorsal margin. According to Cooper it occurs in the Miocene, Pliocene, and Quar-

ternary of California as well as living on the coast from Baulinas Bay to San Diego.

Saxidomus giganteus of Deshayes (as *Venerupis,* 1839), the *S. Nuttallii* of Carpenter, 1864, but not of Conrad, the *S. squalidus* of Carpenter but not of Deshayes, 1853, is the common species of Alaska and Northern California, and is said by Cooper to occur in the Pliocene and Quarternary of Southern California.

Saxidomus gibbosus Gabb, 1866, from the Miocene of Coos Bay, Oregon, and Humboldt County, California, is probably a species of *Marcia* closely related to *M. subdiaphana* Carpenter of the recent fauna of the coast.

Saxidomus Petitii Deshayes is identical with a variety of *Paphia* (*Protothaca*) *staminea* Conrad, 1837, which is abundant from the Miocene up in the Tertiary of California and living on the coast.

Subfamily VENERINÆ.

There does not seem, *a priori,* any very good reason why the presence or absence of a minute pustule of shelly matter in front of the cardinal teeth should count for much in the classification of species, genera, or still less be the criterion for determination of the subfamily to which a species belongs. Yet in making comparisons of the anatomical features of these animals this little tooth or pustule is found an excellent index to important anatomical differences. So whether it has any intrinsic value or not its correlation with important characters for systematic use must be admitted.

The differences indicated already appear with the early *Veneridæ* in the Mesozoic. The lines of development have been varied. On the one hand we note faint granulation or corrugation near or on the posterior cardinals, gradually either splitting up the existing teeth or inducing the establishment of entirely new ones, as in *Tivela.* On another line the teeth descend from thin ancestral Mesozoic progenitors (*Baroda*) to the present representatives of the earlier forms (*Tapes*) with hardly a trace of modification.

Anyone who studies these peculiarities must frequently wonder if the key to all of them will ever be attained, and acknowledge with humility the limitations of our present knowledge.

The present subfamily is characterized by the total absence of lateral teeth. The siphons are usually comparatively short and more or less separate from each other. The foot is hatchet-shaped and, in the adult, not byssiferous except among the nestlers. The young undergo their development outside of the parent shell.

Genus **CYPRIMERIA** Conrad.

Cyprimeria Conrad, Proc. Acad. Nat. Sci. Phila. for 1864, p. 212 (*C. excavata* Morton); Am. Journ. Conch., ii., p. 102, 1866; v., p. 98, 1869; Stoliczka, Cret. Pel. India, p. 157, 1871; Tryon, Syst. Conch., iii., p. 180, 1884; Fischer, Man. de Conchyl., p. 1082, 1887.

?Cyclothyris Conrad, in Kerr, Geol. Rep. N. Car., App., p. 8, 1875; *C. carolinensis* Conrad, *loc. cit.*, pl. ii., fig. 3, 3a, 1875; not *Cyclothyris* McCoy, Brachiopoda, 1844.

This genus is characteristically Cretaceous and has a suborbicular shell, feebly concentrically sculptured, rather heavy and moderately convex, without any circumscribed lunule or escutcheon, the ligament external but set in a depressed area, on each side of which the valves rise to a rounded dorsal limit but without becoming keeled. The internal margins of the valves are smooth. The hinge formula is $\frac{\text{L. } 101010.}{\text{R. } 010101.}$. The first anterior left cardinal and the anterior two right cardinals are entire, the others grooved or bifid. There is no trace of any lateral tooth. The pallial line is almost simple; a slight flexuosity, as in *Circe*, alone represents the sinus. It is obvious that the animal must have had very short siphons, if any, and cannot have been closely related to *Dosinia*, as supposed by Stoliczka. The Indian species with which Stoliczka was familiar are not typical representatives of the genus, and appear to belong to a group to which Conrad gave the preoccupied name of *Cyclothyris*. This has the dental formula of *Cyprimeria* except that the middle left and posterior right cardinals are the bifid ones, and the pallial sinus, though not deep, is well developed and ends in an almost rounded arch in front. Stoliczka describes all his Indian species as more or less deeply sinuate, and therefore they must agree with *Cyclothyris* Conrad. *C. carolinensis* Conrad and *C. Oldhamiana* Stoliczka illustrate this form, while *C. alta* Conrad and *C. discus* Matheron typify the original *Cyprimeria*. To *Cyclothyris* Conrad, not McCoy, I have given the name *Cyclorisma* in Proc. U. S. Nat. Mus., xxvi., p. 357, 1902.

Genus **THETIRONIA** Stoliczka.

Thetis Sowerby, Min. Conch., vi., p. 19, pl. dxiii., 1826, *T. major* Sowerby, *loc. cit.*, p. 20, pl. dxiii., figs. 1 to 4; not *Thetis* Oken, Lehrb. d. Naturg., pp. 278, 280, 1815 (= *Tethys* Cuvier, 1800), nor *Thetis* C. B. Adams, 1845.

Thetironia Stoliczka, Cret. Pel. India, p. 158, 1871; Dall, Proc. U. S. Nat. Mus., xxvi., p. 357, 1902.

?Thetiopsis Meek, Pal. Upper Missouri, p. 191, 1876; *T. circularis* Meek and Hayden, *loc. cit.*, p. 190.

?Tethiopsis Fischer, Man. de Conchyl., p. 1085, 1887.

This Cretaceous form appears to be one of the precursors of the *Veneridæ*, though its hinge is not as well known as could be desired. It appears to resemble *Clementia*, but has a smooth surface more or less granulose or punctate, with three cardinal teeth in each valve and no trace of lateral teeth. There is no indication of lunule or escutcheon, the internal margins are smooth, and the pallial sinus is exceptionally acute, rising nearly to the hinge-line, and very wide at the base. The form described by Meek from the Cretaceous of Nebraska is probably an allied but distinct genus in which the shell is smaller, heavier, and smoother, the hinge heavier, and the sinus shorter and more irregular at its anterior basal part.

It will be noted that the Cretaceous forms referred to this family mostly agree in having no lunular space set off from the rest of the shell, no lateral teeth, and no tendency to radial sculpture or crenulation of the valve margins. We may therefore conclude that these features are characteristic in this family of a more advanced stage of development, though not absolutely restricted to the most modern types.

Genus **MYSIA** Leach.

Mysia (Leach MS.) Lam., An. s. Vert., v., p. 543, 1818 (in synonymy. as communicated by Leach); type *Venus undata* Pennant; Brown, Ill. Conch. Gt. Brit., 1st ed., pl. xvii., figs. 1–2, 1827; 2d ed., p. 98, 1844; Gray, Ann. Mag. N. H., xx., p. 272, 1847; List of Brit. An., Moll., Brit. Mus., p. 5, 1851; Philippi, Handb. Conch., p. 343, 1853.

Lucinopsis Forbes and Hanley, Brit. Moll., i., p. 435, 1848. Type *Venus undata* Pennant.

Not *Mysia* Gray, P. Z. S., 1847, p. 195; Conrad, Fos. Medial Tert., p. 30, 1838; Cossmann, Cat. Ill. Fos. Paris, ii., p. 21, 1887, *et al.*; = *Diplodonta* Brown; nor *Mysea* Billborg, 1820 (Insecta); not *Mysia* Dall and Simpson, Porto Rico Report, 1901.

The name *Mysia* rests on the citation of a synonym by Lamarck under the *Lucina undata* (Pennant, as *Venus*) of the latter author. It is connected only with this species, and if retained at all, must be retained for this reason and no other. The fact that Brown, Gray, and others associated other species with the originally unique type does not authorize the adoption of any of these as typical under the rules of nomenclature. The correct course in this instance was pointed out by Gray and Philippi nearly half a century ago.

The dentition of *Mysia* consists, in the right valve, of two slender divaricating cardinals, the posterior grooved or bifid on the edge; in the left valve are three cardinals, the middle one stout and bifid, the others slender and entire. In Jeffreys' account of the hinge the valves are reversed by some inadvertence.

The hinge-plate is excavated longitudinally, below the lunule, but there is not a trace of lateral teeth.

This genus is sufficiently separated from *Dosinia* by its separated siphonal tubes and the absence in *Mysia* of the small anterior lateral tooth found in the left valve of *Dosinia*. It has been said to have the posterior flexure of *Tellina,* but I cannot find that this is correct. The specimens I have studied are without it. The dental formula is $\frac{L.\ 10101}{R.\ 01010}$. There are no American species.

The subgenus *Lajonkaircia* Deshayes, which has been referred to *Lucinopsis* by several authors, is founded on a recent species of *Petricola,* described as *Venerupis Lajonkairei* by Payraudeau in 1826; figured in the Encyclopédie Méthodique (pl. cclxxii., figs. 2a, 2b) and named in 1827 *Venus cyclolites* Valenciennes by Bory St. Vincent in his explanation of the plates of the Encyclopédie. This has been referred to under *Petricola.* From an examination of a rather imperfect valve, together with the figures of Nyst and S. Wood, I am led to doubt the identity of the crag fossil of England and Belgium with the Mediterranean living form. The most conspicuous distinctive character lies in the hinge, which among other differences has a vastly longer ligament and nymphs in the fossil. This, however, is a question which can best be settled by naturalists on the spot.

Genus **CYCLINELLA** Dall.

Cyclinella Dall, Nautilus, vol. xvi., p. 44, Aug., 1902. Type *Artemis tenuis* Récluz.

Two American recent species have been referred to *Mysia,*—the *Dosinia subquadrata* of Hanley and the *D. tenuis* of Récluz. An examination of these shows, however, that they must be separated from *Mysia,* since they have three cardinal teeth in each valve, the right posterior one bifid, the centrals being stouter than the others but not bifid, the other characters agreeing with those of *Mysia.* The dental formula is $\frac{L.\ 101010.}{R.\ 010101.}$. For this group I have proposed the name of *Cyclinella.* Carpenter referred the *C. subquadrata* to *Cyclina,* which has the central tooth bifid, the margins crenulated, the lunule undefined, and the sculpture reticulate; while in *Cyclinella* the lunule is circumscribed, though not impressed, the margins are entire, and the sculpture concentric. *Cyclina* is said by Adams to have the anatomy like *Dosinia;* so far as one may infer from the shell characters, *Cyclinella* should resemble *Mysia.* Both of the latter differ from the other *Veneridæ* by their nearly vertically directed pallial sinus and by the unusual distance of the posterior adductor scar from the dorsal border above it. In a dried and quite young specimen the foot appears pointed, small, and triangular.

Cyclinella cyclica Guppy.

Dosinia cyclica Guppy, Quart. Journ. Geol. Soc., xxii., p. 582, pl. xxvi., fig. 15, 1866.
Cyclina cyclica Gabb, Geol. St. Domingo, p. 250, 1873.
Lucinopsis cyclicus Dall, Proc. U. S. Nat. Mus., xix., p. 329, 1896.

Eocene of Trinidad at Manzanilla, Guppy, and probably of St. Domingo, Gabb.

This species has a subquadrate shape and differs from all the recent species in having a close concentric sculpture of fine, sharp, somewhat elevated lines. The lunule is large and lanceolate and the hinge typical. Guppy's types are in the collection of the United States National Museum.

Cyclinella gatunensis n. sp.

Plate 52, Figure 18.

Eocene of the Gatun beds on the line of the Panama Canal at Gatun, Colombia; R. T. Hill.

Shell thin, suborbicular, nearly equilateral, with inconspicuous beaks; moderately convex; sculptured with fine, concentric, scarcely elevated lines, near the beaks and on the middle of the disk nearly smooth; lunule elongate, lanceolate, defined by an incised line, not impressed; interior inaccessible. Height 44, breadth 43, diameter about 15 mm.

This species differs from *C. cyclica* in form, in its finer and less elevated sculpture, and in being a more thin and delicate shell. The lunule is also narrower and proportionately smaller.

Cyclinella tenuis Récluz.

Dosinia (Artemis) tenuis Récluz, Journ. de Conchyl., iii., p. 250, pl. x., figs. 1, 1', 1852; iv., p. 415, 1853; Krebs, West Indian Mar. Shells, p. 99, 1864; not *Artemis tenuis* Sowerby, 1852.
Cyclina tenuis Beau, Cat. Coq. Guadeloupe, p. 24, 1858.
Dosinia tenuis Poulsen, Cat. West India Shells, p. 15, 1878.
Lucinopsis tenuis Petit, Journ. de Conchyl., v., p. 155, 1856.
Lucinopsis kroyeri Poulsen, Cat. West India Shells, p. 15, 1878; not of Philippi.
Lucinopsis gundlachi Dunker, in Arango, Fauna Mal. Cubana, p. 252, 1878.
Mysia tenuis Dall and Simpson, Moll. of Porto Rico, p. 487, 1901.

Pliocene of the Caloosahatchie River, Florida, Dall; living (in about two fathoms, sand) from Cedar Keys, West Florida, south through the West Indies and southward to San Paulo, Brazil.

Genus **CHIONE** Megerle von Mühlfeld.

Chione Megerle von Mühlfeld, Mag. Ges. Naturf. Freunde zu Berlin, v., p. 51, 1811; *Venus dysera* Chemnitz (non Linné) = *Venus cancellata* (L.) Lamarck, and *V. gallina* L.; not *Chion* Scopoli, 1777, nor Chione Desvoidy, 1830, *Diptera;* nor *Chionea* Dalman, 1816, *Diptera;* nor *Chionis* Forster, 1788, *Aves;* nor *Chione* Gray, 1838.

Chione Tryon, Syst. Conch., iii., p. 176 (*V. gnidia* L.), 1884.

Chiona Mörch, Cat. Yoldi, p. 24, 1853 (*V. cancellata* Lam.); not Römer, Krit. Unters., p. 16, 1857 (*V. plicata* Gmelin).

Clausinella Gray, List Brit. An. Brit. Mus., p. 12, 1851, *V. fasciata* Da Costa; Dautzenberg, Moll. de Roussillon, ii., p. 382, 1893.

Ortygia Brown, Ill. Conch. Gt. Brit., expl. pls. xix. and xx., 1827; *V. gallina* L. (not *Ortygia* Boie, 1826, *Aves*); Gray, List Brit. An. Brit. Mus., p. 10, 1851; Fischer, Man. de Conchyl., p. 1084, 1887.

Zucleica Leach, Syn. Moll. Gt. Brit., p. 307, 1852; *V. fasciata* Da Costa; Fischer, Man. de Conchyl., p. 1084, 1887.

Hermione Leach, Syn. Moll. Gt. Brit., p. 306, 1852; *V. striatula* Da Costa; not *Hermione* Blainville, 1828, *Vermes.*

Orthygia Mörch (as of Leach) in Synon., Cat. Yoldi, ii., p. 23, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 422, 1857.

Chamelea Mörch, Cat. Yoldi, ii., p. 23, 1853; *V. gallina* L. Römer, Krit. Unters., p. 16, 1857; H. and A. Adams, Gen. Rec. Moll., ii., p. 422, 1857.

Chamelæa Römer, Mal. Blätt., xiv., p. 109, 1867; Tryon, Man., iii., p. 176, 1884; Bucquoy, Dautzenberg, and Dollfus, Moll. de Roussillon, ii., p. 355, 1893 (*V. gallina* L.).

Clausina Römer, Krit. Unters., p. 16, 1857; *V. tiara* Dillwyn; not *Clausina* Brown, 1827, or Jeffreys, 1847.

Timoclea Brown, Ill. Conch. Gt. Brit., expl. pl. xix., fig. 11, 1827 (*V. ovata* Pennant); ed. ii., p. 91, pl. xxxvii., fig. 11, 1844; Mörch, Cat. Yoldi, ii., p. 23, 1853 (*V. granulata* L.); H. and A. Adams, Gen. Rec. Moll., ii., p. 422 (olim), 1857; Tryon, Syst. Conch., iii., p. 176, 1884; Fischer, Man. de Conchyl., p. 1084, 1887.

Pasiphaë Leach, Syn. Moll. Gt. Brit., p. 30, 1852; *V. ovata* Penn; not *Pasiphaë* Spinola, 1851, *Hymenoptera,* nor Risso, Crustacea, 1826.

Cytherea H. and A. Adams, Gen. Rec. Moll., ii., p. 660, 1858; not of Bolten, 1798.

Gomphina Mörch, Cat. Yoldi, ii., p. 19, 1853; *Venus undulosa* Lam. (not H. and A. Adams, Gen. Rec. Moll., ii., p. 424, 1857, or Chenu, 1862, *V. donacina* Ch.); Römer, Krit. Unters., p. 16, 1857; Stoliczka, Cret. Pel. India, p. 149, 1871; Tryon, Syst. Conch., iii., p. 177, 1884; Fischer, Man. de Conchyl., p. 1086, 1887.

Omphaloclathrum Tryon, Syst. Conch., iii., p. 176 (in synon.), 1884; not of Mörch, 1853.

Parvivenus Sacco, Moll. Piem. e Lig., xxviii., p. 45, 1900. Type *Venus marginata* Hœrnes (= *Chamelea* Mörch, 1853).

Lirophora Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 575, 586, 1863; Meek, S. I. Checkl. Miocene Fos., p. 9, 1864; *Venus athleta* Conrad.

Marcia (pars) H. and A. Adams, Gen. Rec. Moll., ii., p. 423, 1857 (no type selected); Chenu, Man. Conch., ii., p. 81, 1862 (*V. undulosa* Lam.); Tryon, Syst. Conch., iii., p. 178, 1884 (*V. undulosa* Lam.); not Fischer, Man. de Conchyl., p. 1086 (*Venus exalbida* Lam.), 1887.

Leukoma Römer, Krit. Unters., p. 17, 1857, *V. granulata* Gmelin (not *Leucoma* Stephens, 1829, *Lepidoptera*); Malak. Blätt., xiv., p. 92, 1867.

Leucoma Stoliczka, Cret. Pel. India, p. 148, 1871; Fischer, Man. de Conchyl., p. 1084, 1887; not *Leucoma* Stephens, 1829.

<*Murcia* Römer, Krit. Unters., p. 16, 1857; Mal. Blätt., xiv., p. 28, 1867; not *Murcia* Koch, 1835, *Arachnida.*

Anaitis Römer, Krit. Unters., p. 16, 1857; no type selected; Stoliczka, Cret. Pel. India, p. 149, 1871; Fischer, Man. de Conchyl., p. 1084, 1887, *V. pophia* L.; not *Anaitis* Duponchel, 1829, *Lepidoptera.*

Chione Deshayes, Cat. Conch. Brit. Mus., i., p. 118, 1853 (in five sections); H. and A. Adams, Gen. Rec. Moll., ii., p. 420, 1857.

This group contains solid trigonal shells which have three cardinals in each valve and (excepting a few aberrant species) have the valve margins entirely crenulate; all have a small triangular sinus, a lunule circumscribed by an incised line, an escutcheon not limited by any line and defined chiefly by a deficiency of coarse sculpture and a more or less pronounced ridge radiating from the beak towards the posterior margin. The ligament, though inset, is usually visible externally; some of the central cardinals may be grooved or bifid; rugosities appear on the hinge in a few instances. The sculpture is variable, chiefly comprising concentric ribs or lamellæ and less prominent radials.

A few, mostly small forms, have the concentric sculpture less prominent than the radial. The lamellæ are often expanded into elegant leaflike processes distally. In a number of cases the right posterior dorsal margin is grooved to receive the bevelled edge of the opposite valve behind the hinge-plate. In *Gomphina* alone is any trace of a corresponding grooving anteriorly. The genus may, for convenience, be divided into a number of groups, as follows:

Subgenus *Chione* s. s. Type *C. cancellata* Linné.

Sculpture of radial ribs decussated by concentric, sharp, elevated lamellæ; the dental formula is $\frac{\text{L. 101010.}}{\text{R. 010101.}}$, the teeth are usually entire and smooth or feebly channelled. The siphons are short and partly separated.

Section *Chione* s. s. Type *C. cancellata* Linné.

In a few of the larger species, like *C. gnidia,* a feeble fourth cardinal is barely perceptible below the ligament of the right valve and almost coalescent

with the nymph. The merest trace of a similar tooth sometimes occurs in *C. cancellata.*

Section *Timoclea* Brown. Type *Venus ovata* Pennant.

Sculpture predominantly radial, the concentric element feeble; the middle left and two posterior right cardinals grooved; the escutcheon smooth. The siphons are united to their orifices in this group.

Section *Clausinella* Gray. Type *Venus fasciata* Da Costa.

Sculpture of broad concentric waves and fine concentric striæ, radial sculpture obsolete; the concentric waves not pinched out behind; the ligament covered by the margin of the valves when closed. The siphons are short and partly united.

Section *Lirophora* Conrad. Type *Venus athleta* Conrad; a recent species is *V. paphia* Linné.

Sculpture of broad concentric waves, attenuated and often conspicuously lamellose distally; radially striate; ligament not covered by the valve margins; the edges of the right nymph and of the left posterior cardinal with interlocking rugosities.

?Section *Volupia* Defrance, 1829.* Type *V. rugosa* Defrance. Eocene of Hauteville.

Shell small, sculpture resembling that of *Lirophora,* but with the lunule and a posterior area large, defined by a deep sulcus, dividing the disk into three areas which are crossed by a few thick, swollen, adjacent concentric ribs; beaks high, curved as in *Isocardia;* hinge-teeth three, of which one is bifid, received into pit-like sockets; pallial line entire.

In placing this shell here I have followed Fischer, as above cited, not having been able to obtain specimens or definite information as to its characters. The figures given by Defrance and copied by Bronn are so obscure, and the diagnoses so far from clear or complete, that it will require a reëxamination of the fossil to enable its proper place in the system to be determined. I should from the wretched lithograph given in the Dictionnaire suspect the shell to be Lucinoid and belong somewhere near *Here* Gabb, but this is mere

* *Volupia* Defrance, Dict. Sci. Nat., lviii., p. 451, atlas, fossiles, pl. xcvii., fig. 1, 1829; Deshayes, Enc. Méth., iii., p. 1134, 1832; Bronn, Lethæa Geogn., p. 943, pl. xxxviii., fig. 12, 1838; Fischer, Man. de Conchyl., p. 1084, 1887.

speculation. The shell is said by Defrance to be about five millimetres in length.

Section *Chamelea* Mörch. Type *Venus gallina* Linné.

Sculpture of narrow, close concentric waves or low lamellæ without radials or distal lamellation; teeth entire; escutcheon and lunule smooth; the ligament exposed. The siphons are partly united.

Subgenus *Gomphina* Mörch. Type *Venus undulosa* Lamarck.

Valves more or less extended behind and pointed; surface usually smooth and polished; inner margins not crenulate, anterior left and posterior right dorsal margins beyond the hinge-plate grooved to receive the bevelled edge of the opposite valve; lunule long and narrow; the posterior right and two anterior left cardinals grooved; the ligament exposed; pallial sinus short, free, and rounded in front.

Section *Gomphina* Mörch s. s. Type *Venus undulosa* Lam.

Lower edge of the right nymph and upper edge of the left posterior cardinal with reciprocal rugosities. Most of the species of this group are heavy, inequilateral, solid, and very tumid. *Tapes pinguis* Sowerby, in the Thesaurus, pl. cxlvi., figs. 20–23, is really more typical of this group than the nominal type. *Marcia* Chenu, not Fischer, is synonymous.

Section *Macridiscus* Dall. Type *Venus æquilatera* Sowerby.

Nymphs and teeth smooth, entire; valves in general more compressed, equilateral, and trigonal than in the preceding section; less heavy, and sometimes with feeble striation distally.

Venus faba Reeve and *V. fumigata* Sowerby seem to belong to this section. It is *Gomphina* H. and A. Adams, not Mörch.

The American species of the section *Chione* are naturally divisible into three groups, each of which has a representative in each horizon from the Oligocene up. These are (1) the group of *C. cancellata,* which has the shell trigonal and the concentric lamellæ rather distant; (2) the group of *C. subrostrata* Lamarck, which has the sculpture delicate and the concentric lamellæ rather close and low, with the shell produced and compressed behind; and (3) the group of *C. pubera* Valenciennes, which has the concentric lamellæ close, very numerous, and crenulate, so that the interspaces have a punctate appearance.

(Group of *Chione cancellata.*)

Chione chipolana n. sp.

PLATE 55, FIGURE 20.

Oligocene of the Chipola horizon at Alum Bluff and on the Chipola River, Calhoun County, Florida; Dall and Burns.

Shell moderately convex, in general much resembling *C. cancellata,* but smaller, with the radial sculpture finer, the radii more numerous, the concentric lamellæ more regularly, evenly, and distinctly fluted on the ventral side, the lunule larger, and the pallial sinus more sharply angular. The mutations of the individuals pass through about the same range as in *C. cancellata,* but modified by the differences above noted. Length of a fully adult specimen 32.0, height 25.5, diameter 18.0 mm.

Chione erosa n. sp.

PLATE 55, FIGURES 5, 8.

Miocene of Florida, sixteen miles southwest of Tallahassee near and at Jackson Bluff (upper bed); Vaughan.

Shell rather large, compressed, the sculpture behind the middle of the disk obsolete, the radial feebly defined, the concentric lamellæ little elevated and distant; hinge normal, the teeth entire; anterior adductor scar elongated, posterior shorter and smaller; pallial sinus nearly obsolete; lunule slightly larger and proportionately narrower than in *C. cancellata.* Length 35, height 32, diameter 17 mm.

Many of the specimens have the sculpture almost entirely obsolete.

Chione sp. indet.

Miocene marl near Petersburg, Virginia; Burns.

Two valves in rather worn condition were obtained by Mr. Burns, as stated. They are small, heavy, considerably exfoliated, with a small but sharp and angular pallial sinus, and very rounded, almost orbicular. The concentric lamellæ are thick and heavy, and have a tendency to coalesce. The specimens are too imperfect to deserve naming, but indicate very distinctly that a species occurs in the Chesapeake Miocene, and they are for that reason noted here. Length 17, height 16, diameter 10 mm.

Chione cancellata Linné.

Venus cancellata Linné, Syst. Nat., ed. xii., p. 1130, 1767; Sowerby, Thes. Conch., ii., p. 710, pl. liv., figs. 28–31, 1853.

Venus cingenda Dillwyn, Cat. Rec. Shells, i., p. 161, 1817; Wood, Index Test., pl. vii., fig. 6, 1828.

Venus dysera Auctorum, non Linné.

Venus clevata Say, Journ. Acad. Nat. Sci. Phila., ii., p. 272, 1822.

Venus lamellata Deshayes, Cat. Conch. Brit. Mus., p. 134, 1853, in synonymy; not of Linné.

Chione cancellata Deshayes, *op. cit.*, p. 134, 1853.

Dione (Chamelea) cancellata Meek, Checkl. Miocene Fos. N. Am., p. 10, 1864.

?Miocene of the Galveston artesian well, Harris, and of the Sumter district, South Carolina, Tuomey and Holmes; Pliocene of the Caloosahatchie beds of the Caloosahatchie River, Alligator Creek, and Shell Creek; Pleistocene of Osprey, Florida, at North Creek, and in Quaternary beds generally throughout the State; also at Simmons Bluff, South Carolina; recent from Cape Fear, North Carolina, to the West Indies.

It is possible that this species does not appear in the Miocene, and that Holmes' South Carolina specimens, some of which are before me, are really Pliocene. They have that aspect and no specimens from undoubted Miocene strata are in the National Collection.

Chione mississippiensis Conrad, from the Vicksburgian, appears to be rare. Among many collections made at the typical locality none has been found. *Chione simillima* Sowerby and *C. succincta* Valenciennes are not uncommon in the Pleistocene of San Diego, California, and still live on the adjacent coast.

(Group of *Chione subrostrata.*)

Chione Walli Guppy.

Venus Walli Guppy, Quart. Journ. Geol. Soc. Lond. (v.), xxii., p. 580, pl. xxvi., fig. 16, 1866.

Eocene of Manzanilla, Trinidad, Guppy; Oligocene of Bowden, Jamaica, Vendryes.

This species has the aspect of being the precursor of *C. subrostrata, C. amathusia,* and similar forms of the recent fauna.

(Group of *Chione pubera.*)

Chione Woodwardi Guppy.

Venus Woodwardi Guppy, Quart. Journ. Geol. Soc. London (v.), xxii., p. 292, pl. xviii., fig. 1, 1866.

Oligocene of the Bowden marl at Bowden, Jamaica, and the same horizon in Haiti; Guppy and Vendryes.

Guppy's figures of this and several other species in the paper cited are very inadequate and inaccurate.

Chione sp. indet.

Oligocene of the Chipola horizon at Alum Bluff, Calhoun County, Florida; Burns.

Fragments of a species belonging to this group, but too imperfect for description, though probably distinct from those which follow, were collected as stated.

Chione cortinaria Rogers.

Venus cortinaria Rogers, Trans. Am. Phil. Soc., N. S., v., p. 333, 1835, and vi., pl. xxxvi., fig. 7, 1839; Conrad, Fos. Medial Tert., i., p. 11, pl. viii., fig. 1, 1838.

Dione (*Chamelea*) *cortinaria* Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 575, 1864.

Miocene of Grove Wharf and Williamsburg, James River, Virginia, Rogers and Burns; and of Jackson Bluff, south of Tallahassee, Florida, Vaughan.

Shell moderately convex, rounded trigonal or ovate, with low, small, somewhat prosogyrate beaks, a rather narrow cordate lunule, and a long, nearly smooth escutcheon, having in the left valve a stout striated rib adjacent to the ligament; surface of the disk with obscure radial sculpture chiefly evident as reflected by the fluting of the concentric lamellæ; the latter near the ends of the shell, especially behind, are thin, elevated, and closely regularly fluted; on the middle of the disk they are depressed, recurved, flattened, and with the flutings prominent on the basal portion of the lamellæ; hinge normal; adductor scars subequal; the pallial sinus well developed, linguiform, ascending. Length 25, height 23, diameter 16 mm.; length of an imperfect valve from Jackson Bluff 37, height 33, diameter 18 mm.

The Florida specimens are more or less eroded, but appear to be identical.

Chione cribraria Conrad.

Venus cribraria Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 310, Oct., 1843; Fos. Medial Tert., iii., p. 67, pl. xxxviii., fig. 2, 1845; Emmons, Geol. N. Car., p. 293, fig. 218, 1858.

Dione (*Chamelea*) *cribraria* Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 575, 1864; Meek, Checkl. Miocene Fos., p. 10, 1864.

Upper Miocene of Wilmington, of the Natural Well, Duplin County, of Cape Fear, and of Magnolia, North Carolina; Conrad, Burns, Yarrow, and Stanton.

This species, doubtless the descendant of the lower Miocene *cortinaria,* differs from it by having the lamellæ less crowded and passing, erect and fluted, clear across the disk, without the depression and thickening observable in the other species. A specimen from near the typical locality measures: length 40, height 36, diameter 24 mm.

The recent species of the coast, representing *C. cribraria* in the present fauna, is *C. intapurpurea* Conrad. It has often been confused with the present species, but I regard them as undoubtedly distinct. *C. intapurpurea* has reverted in its sculpture to a type more nearly recalling the older Miocene one than that of the upper Miocene: an interesting lesson to some of our enthusiastic but inexperienced students who propose to overthrow the geological sequence of the strata because the development of some fossils from stage to stage does not fit in with their theoretical scheme of evolutionary progression.

Section *Lirophora* Conrad.

In this section we have an interesting exhibit of development from forms like those just described to those in which the middle concentric ribbing becomes dense and heavy, then irregular, more or less coalescent and finally entirely so, and of reversion to the earlier type under circumstances, we may assume, which make it better suited to the environment than that which had been laboriously evolved. In the existing faunas we have *C. Kellettii* of the Pacific coast, in which the coalescent ribs form a smooth, even surface on the middle of the disk, with high, leaflike expansions distally; forms like *C. paphia,* in which the ribs have become even and regular; and still others, wanting the distal expansions, in which the size and sequence of the thick ribs seems to depend on mere luck or accident. So that we may have an evolution from a clear-cut, elegant, attractive type of sculpture to a dull, unformed, irregular type, which in its turn may meet the difficulties of the situation better than the former.

Chione (Lirophora) victoria n. sp.

Plate 55, Figure 17.

Lower Oligocene of Vicksburg, Mississippi; P. Crutcher and F. Burns.

Shell ovate, moderately convex, with low, prosogyrate beaks and a small, cordate, striated lunule; the escutcheon is flattened and finely striated; surface sculpture of twenty or more elevated recurved lamellæ, more or less depressed and thickened anteriorly, more erect, distant, and higher behind; the only

radial sculpture is of faint striation on the ventral side of the lamellæ, insufficient to flute them; hinge as usual, the two anterior left and posterior right cardinals grooved distally, the posterior adductor scar larger than the anterior one; the pallial sinus small, sharply angular; interior marginal crenulation fine and regular. Length 24.5, height 20.5, diameter 14.0 mm.

This interesting species is, as it were, just launched on its career towards the typical *Lirophora;* a trifle might have given it the same impetus towards *Chamelea.*

Chione (Lirophora) Burnsii Dall.

PLATE 41, FIGURES 4, 11; PLATE 42, FIGURE 5a.

Venus (Anaitis) Burnsii Dall, Trans. Wagner Inst., iii., p. 1198, pl. lxi., figs. 4, 11, 1900.

Oligocene of the Chipola horizon at Alum Bluff and on the Chipola River; Burns and Dall.

Shell subtrigonal, heavy, moderately convex, with low prosogyrate beaks over a striated cordate lunule, with the escutcheon elongate, nearly smooth, bounded by a well-marked keel; beaks with a few distant, low, concentric lamellæ; later the ribs become greatly thickened and recurved with narrower interspaces or more commonly confluent, suddenly pinched out behind, where they rise in thin, elevated foliations, and below the lunule in front are somewhat similar but more crowded; these ribs are crossed by faint radial striations sharper towards the beaks but not visible in the interspaces; hinge normal, teeth entire, adductor scars subequal; pallial sinus angular, small. Length 34, height 26, diameter 16 mm.

Except in the radial striation this species recalls the recent *C. Kellettii* Hinds of the Pacific coast fauna. The ribbed form is close to *C. glyptocyma* of the Oak Grove sands, but may be distinguished by the sculpture of the beaks.

Chione (Lirophora) mactropsis Conrad.

Gratelupia? mactropsis Conrad, House Ex. Doc. 129, Rep. of W. P. Blake, App., p. 18, July, 1855; Pacific R. R. Reps., v., p. 328, pl. vi., fig. 54, 1856.

Chione sulcata Gabb, Proc. Acad. Nat. Sci. Phila. for 1860, p. 567, 1861.

Eocene? and Oligocene of the Isthmus of Darien, Blake; of Gatun and Vamos-a-vamos on the line of the Panama Canal, Agassiz; 10.5 kilometers west of Colon, R. T. Hill; Chiriqui, Dr. John Evans (Gabb).

This species was represented by an internal cast in W. P. Blake's collection, which was described and figured as above cited by Conrad. It is a species closely related to *C. Burnsii,* but more compact and rough, the foliaceous area

behind narrower and with more numerous foliations; the identity of the concentric ribs not so much lost in confluence; the beaks closely ribbed to their apices, and the escutcheon somewhat smaller. A specimen intact measures: length 30, height 23, diameter 15 mm., but fragments show that it attains a larger size at times. The age of the beds from which it comes is certainly Oligocene in the last instance: whether the others are older or not is not yet positively known.

Chione (Lirophora) ballista n. sp.

PLATE 55, FIGURE 23.

Oligocene silex beds at Ballast Point, Tampa Bay, Florida; Crosby, Burns, and Dall.

Shell rather small, arcuate-trigonal, with small, acute umbones, and from eight to ten heavy concentric recurved ribs, not confluent but bent backward and attenuated near the posterior dorsal border; lunule narrow, striated, small; also the escutcheon; obsolete radial striation sometimes visible on the ventral side of the larger ribs, but not in the interspaces; anterior and posterior ends often but not always pointed; base and posterior dorsal border arcuate; interior normal. Length 24.0, height 19.5, diameter 12.0 mm.

This species is apt to be confounded with *Artena glyptoconcha,* of the same horizon, unless attention is called to the absence of the minute anterior lateral on the hinge, and of the fine concentric striation in the *Chione.* It considerably resembles the next species, which, however, has more numerous and basally punctate ribs, which are pinched off at about the posterior third of the shell, while in this species the attenuation is less and is close to the dorsal margin.

Chione (Lirophora) Hendersonii n. sp.

PLATE 55, FIGURE 22.

Venus paphia Guppy, Quart. Journ. Geol. Soc. London, xxxii., p. 530, 1876; Geol. Mag., Dec. 2, vol. i., p. 450, 1874, etc., *ex parte.*

Oligocene of the Bowden marl at Bowden, Jamaica, Henderson and Simpson, and of Haiti, Guppy.

Shell resembling the last species, but with about fifteen ribs on the ventral bases, of which the radial sculpture is represented by a series of punctuations which are rarely drawn out into striæ; the ribs are closer together, sometimes obscuring the interspaces; the imaginary line at which the thick ribs suddenly become very thin and elevated marks off the posterior third of the shell, more than in any other species noted; the foliations are very thin and were pre-

sumably elevated, but are destroyed in all the specimens examined. In harmony with this arrangement of the sculpture the posterior end of the shell is somewhat rostrate; the lunule and escutcheon are wider than in *C. ballista;* the hinge normal, the teeth entire, the pallial sinus small and angular, and the adductor scars subequal. Length of an average specimen 27.5, height 20.5, diameter 14.0 mm.

The Bowden species was confused with others and with the recent *C. paphia* by Guppy, as above cited. Only a comparison is needed to prove their distinctness.

Chione (Lirophora) glyptocyma n. sp.

Plate 55, Figure 21.

Oligocene of the Oak Grove sands, at Oak Grove, Santa Rosa County, Florida; Smith, Burns, and Aldrich.

This species is very close to the ribbed variety of *C. Burnsii,* from which it is best distinguished by a differential description.

In *C. Burnsii* there is a slight inflection of the posterior base in front of the posterior dorsal area which gives the hinder end of the shell a look as if it were slightly bent down; in the present species the base is evenly arcuate and the rostration points backward. In *C. Burnsii* there are but three or four concentric lamellæ on a young shell five millimetres in height; in the present species eight or nine. By looking at the beaks the two can be at once separated. In *C. glyptocyma* there are from sixteen to twenty-three ribs, in *C. Burnsii* when the ribs are not confluent there are nine to eleven. The surface of *C. glyptocyma* is more polished; the radial striation on the ventral aspect of the ribs stops at their base in *C. Burnsii;* in the present species it continues over the interspace to the base of the rib below. In *C. glyptocyma* the ribs are apparently never normally confluent, but in *C. Burnsii* confluence is the rule. An average specimen measures: length 33, height 24, diameter 16 mm., but the form may be longer or more trigonal, as in all these species I have figured a youngish valve 26.5 mm. long, because it shows remains of the foliations which in adult specimens are always broken off. The pallial sinus is very small and angular, the adductor scars subequal, and the teeth are entire.

Chione (Lirophora) ulocyma Dall.

Plate 42, Figure 5.

Chione ulocyma (Dall MS.) Harris, Bull. Am. Pal., i., No. iii., p. 9, 1895.

Venus (Anaitis) ulocyma Dall, Trans. Wagner Inst., iii., part v., p. 1198, pl. xlii., fig. 5, 1900.

Miocene of Alum Bluff, Calhoun County, Florida, Dall and Burns; of Jackson Bluff and other localities nine to sixteen miles southwest of Tallahassee, Vaughan; and between 2236 and 2650 feet in the artesian well at Galveston, Texas, Texas Geological Survey.

Shell elongate-ovate, subcompressed, produced distally, inequilateral beaks low, prosogyrate, closely concentrically sculptured; lunule impressed, finely striated, cordate in the young, lanceolate in the full-grown; escutcheon large, striated, defined by a carina; sculpture of the disk foliate in front and behind, the middle portion with (normally) numerous thick, depressed, recurved concentric ribs which conceal the interspaces; exceptionally these ribs may be separated or coalescent, but it is rare that the interspaces are not indicated by sulci; these are crossed by shallow radial grooves, which, when the interspaces are visible, also cross them; anteriorly the ribs are convex ventrally, but behind the middle of the shell they show a moderate dorsal convexity, giving a flexuous aspect to the shell; distally the ribs are compressed and elevated, but the foliations are rarely preserved; internally the hinge is delicate but normal, the teeth entire, the anterior and basal margins crenulate, the adductor scars subequal, the pallial sinus very small but sharply angular. Length 45, height 32, diameter 18 mm.

The figure of the young shell of *C. Burnsii* was by an accidental transposition referred to this species in the explanation of plate xlii. This is the largest of the *Lirophora* group in the Florida Tertiary and runs the gamut of variation, like the others. It is more like the Panama Oligocene species than any of the others, but that is smaller, less foliaceous, and relatively more plump and ovate.

Chione (Lirophora) xesta n. sp.

Plate 55, Figure 18.

Miocene of Alum Bluff, Calhoun County, Florida; Burns and Dall.

Shell small, rounded-trigonal, with low, usually sparsely sculptured beaks, a striated cordate lunule, and feebly defined striated escutcheon; sculpture in general resembling that of the other species, but with the ribs high and sharp, or only slightly thickened, clear across the disk, though more elevated distally; the radial striation appears on the ventral side of the ribs, is not emphatic, and does not cross the interspaces, which are concentrically striated; there are about twenty ribs; interior as in the *C. ulocyma*, the base evenly arcuate and not flexuous. Length 30, height 25, diameter 16 mm.

This species recalls the Vicksburgian *C. victoria*, which has a smaller lunule, larger pallial sinus, and denser and more elevated concentric lamellation.

Chione (Lirophora) alveata Conrad.

Venus alveata Conrad, Journ. Acad. Nat. Sci. Phila., vi., p. 264, pl. xi., figs. 14, 15, 1831; Morton's Syn. Org. Rem., App., p. 2, 1834; Fos. Medial Tert., p. 9, pl. v., fig. 2, 1838; not of Say, Am. Conch., vii., pl. lxiii., 1833.

Circumphalus (*Lirophora*) alveatus Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 575, 1864.

Chione (*Lirophora*) *alveatus* Meek, Checkl. Miocene Fos. N. Am., p. 9, 1864.

Miocene of Maryland at St. Mary's River, and of Virginia at Windmill Point, James River; Meek.

This fine species is readily recognized by its high, trigonal form, few high, even, recurved concentric ribs, and absence of radial sculpture. It was confused by Say with another species which he figured under this name from North Carolina, where, so far as I have been able to discover, *C. alveata* is unknown.

Chione (Lirophora) latilirata Conrad.

PLATE 42, FIGURE 3.

Venus paphia Lamarck, An. s. Vert., v., p. 608, No. 2, 1818; not of Linné, Syst. Nat., ed. xii., p. 1129, 1767.

Venus alveata Say, Am. Conch., vii., pl. lxiii., 1833; not of Conrad, 1831.

Venus latilirata Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 28, 1841; Fos. Medial Tert., p. 68, pl. xxxviii., fig. 3, 1845.

Venus varicosa Sowerby, Thes. Conch., ii., p. 723, pl. clv., fig. 67, 1853; Dall, Bull. U. S. Nat. Mus., No. 37, p. 54, 1889.

Venus latilirata Tuomey and Holmes, Pleioc. Fos. S. Car., p. 85, pl. xxi., fig. 12, 1857; Emmons, Geol. Rep. N. Car., p. 293, fig. 219, 1858; Dall, Trans. Wagner Inst., iii., p. 1198, pl. xlii., fig. 3, 1900.

Circumphalus (*Lirophora*) *latiliratus* Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 575, 1864.

Circumphalus (*Lirophora*) *athleta* Conrad, *op. cit.*, pp. 575, 586, 1864.

Chione (*Lirophora*) *athleta* Meek, Checkl. Miocene Fos. N. Am., pp. 9, 30, 1864.

Chione (*Lirophora*) *latilirata* Meek, *op. cit.*, pp. 9, 30, 1864.

Lower Miocene of Plum Point and Calvert Cliffs, Maryland (type locality); of Virginia at Yorktown; upper Miocene of North Carolina at Magnolia and the Natural Well, Duplin County, and at Wilmington, Burns and Stanton; of Florida at Jackson Bluff, Ocklocknee River; Pliocene of South Carolina on the Waccamaw River at Tilly's Lake, C. W. Johnson; of Florida in the Caloosahatchie beds on the Caloosahatchie, Shell Creek, and Alligator Creek, Dall and

Willcox; living on the coast of America and the West Indies from Cape Hatteras, North Carolina, to Rio Grande do Sul, Brazil, in ten to one hundred and twenty-four fathoms, United States Fish Commission.

The typical Calvert Cliffs specimens when compared with well-grown regular specimens of the recent shell certainly look very different, and Conrad was hardly blameworthy for separating them, but having a very large series, both recent and fossil, and having compared them with a prepossession towards the opinion that they are distinct, I have been compelled to decide that no line can be drawn, and some of the recent shells cannot be distinguished by any diagnostic characters from those from the lower Miocene.

Section *Timoclea* Brown.

Chione (Timoclea) grus Holmes.

Tapes grus Holmes, Post-Pl. Fos. S. Car., p. 37, pl. vii., fig. 5, 1858.
Venus parva Sowerby, Thes. Conch., ii., p. 787, pl. clxviii., figs. 227–228, 1854 (not of Sowerby, 1829, nor of Münster, 1836).
Venus trapezoidalis Kurtz, Cat. Sh. N. and S. Car., p. 5, 1860.
Chione parva Römer, Mal. Blätt., xiv., p. 60, 1867.
?*Venus antillarum* Orbigny, Mal. Cubana, ii., p. 278, pl. xxvi., figs. 41–43, 1853.
Venus pygmæa Dall (*ex parte*) Bull. U. S. Nat. Mus. No. 37, p. 54, 1889.

Miocene of North Carolina at the Natural Well and Magnolia, Duplin County; of Florida at Jackson Bluff, Ocklockonnee River, Vaughan; Pliocene of the Caloosahatchie and Shell Creek, Florida, Dall and Burns; Pleistocene of Simmons Bluff, South Carolina, Holmes; living from Cape Hatteras, North Carolina, to Yucatan in twelve to sixty-three fathoms, United States Fish Commission.

This modest little shell I believe to be the *Venus antillarum* of Orbigny, who reports it as living from Florida to Martinique, but his description is so brief and his figure so different that I prefer to use a later name about which there can be no question as to its identity in the absence of authentic specimens of Orbigny's shell. For many years it was confounded with *Venus pygmæa* Lamarck, which is a near relative, and that confusion was carried into my list of 1889. *Venus pygmæa* occurs among the Florida reefs, but I have seen nothing of it from farther north.

A species of *Timoclea* recalling *C.* (*T.*) *granulata* Gmelin occurs in the Oligocene of an island in Lake Henriquillo, St. Domingo, but my specimen is too much crushed to base a new species upon.

Section *Chamelea* Mörch.

Chione (? Chamelea) craspedonia n. sp.

Plate 55, Figure 2.

Lower Oligocene of Vicksburg and Eocene of Red Bluff, Mississippi; Burns, Schuchert, and Johnson.

Shell short-ovate or rounded-trigonal, inequilateral, the beaks nearly smooth, low, prosogyrate, situated slightly behind the anterior third; lunule cordate, sharply defined by an incised line, not impressed, nearly smooth; escutcheon elongate, sharply defined by a keel which is more pronounced on the left valve; surface sculptured with small, regular, even concentric lamellæ, separated by wider interspaces which are concentrically striated; the lamellæ on the anterior two-thirds of the shell frequently show obsolete cross-striation which does not affect the interspaces; anterior slope nearly straight, posterior slope somewhat convex, ends rounded, base convexly arcuate; hinge well developed, the larger cardinals sometimes faintly grooved; adductor scars nearly equal; pallial sinus small, angular; basal and anterior margins minutely crenulate. Length 28, height 24, diameter 14 mm.

I thought at first that this attractive species might be referred to *Chione* s. s., but finally decided to put it in this section with a mark of doubt. It is certainly on the border line between the two sections. There is some variation in the closeness of the lamellation, though very little in the general form. The figure given by Conrad of the *Chione mississippiensis* is so remarkably different in outline that, unless Conrad's type was entirely abnormal, no question of their identity could arise.

Chione (Chamelea) nuciformis Heilprin.

Plate 55, Figure 9.

Cytherea nuciformis Heilprin, Trans. Wagner Inst., i., p. 116, pl. xvi., fig. 61, 1887.

Oligocene silex beds of Ballast Point, Tampa Bay, Florida; J. Shepard and A. Heilprin.

The original shell was so very poorly figured that it seemed desirable to illustrate it. It very much resembles the following species in the character of the sculpture and the form and size of the lunule, beaks, and ligament as well as the internal characters. It differs in the following particulars: the beaks are on the average higher, the escutcheon is sharply striated and not distinctly differentiated from the rest of the surface, while in the next species the area is marked off by a distinct keel within which, in the left valve, the escutcheon

is flat and smooth; in the right valve the keel is less distinct and the escutcheon less smooth, but these features are, nevertheless, distinct. The species has no radial sculpture. Length of shell 24, height 21, diameter 13 mm.

Chione (Chamelea) spada n. sp.

PLATE 55, FIGURE 13.

Oligocene of the silex beds of Ballast Point, Tampa Bay, Burns, Dall, and Crosby; and of Bailey's Mill Creek Sink, Florida, L. C. Johnson.

Shell resembling *C. nuciformis* but more produced and pointed behind, with a distinct keel bordering the escutcheon, which is flat and smooth in the left valve; hinge normal, adductor scars subequal, pallial sinus small, angular; there is usually no radial striation, but the inner margins of both species are minutely crenulate. Length (elongate specimen) 29, height 23, diameter 14 mm.; of a short specimen, length 28, height 24, diameter 16 mm. Some specimens reach a length of 33 mm., and one of these shows a few obsolete radial striæ on the anterior portion of the disk, but as these appear only on one valve they are probably pathological. Among some fifty other valves no other shows any radial sculpture.

Chione (Chamelea) rhodia n. sp.

PLATE 55, FIGURE 10.

Oligocene of the Ballast Point silex beds near Tampa, Florida, Dall; and of the Oak Grove sands, Santa Rosa County, Florida, Burns.

Shell small, solid, inequilateral, the beaks at the anterior sixth, high, pointed, decurved, over an impressed, cordate, striated lunule of moderate size; escutcheon elongated, large, smooth in the left valve, bordered by a keel at which the concentric sculpture ceases; anterior slope short, concave, posterior arcuate, both ends bluntly rounded, base evenly arcuate; sculpture of concentric lamellæ more elevated on the posterior slope, with wide concentrically striated interspaces and no radial sculpture; hinge well developed, pallial sinus angular, nearly reaching the middle of the shell, adductor scars subequal; inner margins minutely crenulate. Length 18, height 17, diameter 10 mm.

Though this species is only represented by a small amount of material, it seems a well-characterized form.

Genus **ANOMALOCARDIA** Schumacher.

Anomalocardia Schumacher, Essai, pp. 44, 134, 1817; *Venus fluctuosa* L.; Gray, P. Z. S., 1847, p. 183.

Triquêtre Blainville, Dict. Sci. Nat., x., Tableau, 1818; Malacologie, p. 557, 1825 (not

latinized); *V. subrugosa* Lamarck; not Triquetra Conrad, 1846, or Herrmannsen, after Klein, 1849.

Triquetra Anton, Verzeichn., p. 10, 1839; *V. fluctuosa* L.

Cryptogramma Mörch, Cat. Yoldi, ii., p. 22, 1853. First species *V. subrugosa* Wood; H. and A. Adams, Gen. Rec. Moll., ii., p. 420, 1857; Römer, Mal. Blätt., xiii., p. 20, 1867; *V. flexuosa* L.; Stoliczka, Cret. Pel. India, p. 148, 1871; Tryon, Syst. Conch., iii., p. 176, 1884; Fischer, Man. de Conchyl., p. 1083, 1887.

Anomalocardia Deshayes, Cat. Conch. Brit. Mus., i., p. 115, 1853; Römer, Krit. Unters., p. 17, 1857; Dall, Bull. 37, U. S. Nat. Mus., p. 54, 1889.

This group is distinguished by its general aspect and similarity of the species rather than by strongly marked characters, and if it had not been generally accepted I should have been tempted to regard it as merely a subgenus of *Chione*.

The dental formula is $\frac{\text{L. } 101010.}{\text{R. } 010101.}$. The teeth are entire and rather slender and diverge widely from their common centre. The upper side of the posterior left cardinal and the lower edge of the right nymph are usually minutely rugose. The external sculpture usually is of coarse, more or less confluent, concentric ribs, with obsolete radial striæ, though when the shell disintegrates under the influence of decay it is seen to have internally a strong radial element in its structure. This hidden radiation probably suggested to Mörch the name he applied to the genus. The sculpture of the shell is often obsolete at the middle of the valves, which in the typical group are covered by a vernicose olivaceous periostracum. The inner margins are crenulate and the valves attenuated and more or less nasute behind. The ligament is exposed and rather short; the lunule and escutcheon impressed, the posterior right dorsal margin grooved to receive the edge of the opposite valve. The beaks are rather pointed in most of the species and the pallial sinus is very small, angular, and sometimes almost obsolete. Most of the species are very solid and heavy. A species (*A. leptalea* Dall) from the lagoons of Watling's Island, Bahamas, differs from all the others in its extreme thinness and less prominent beaks. As this is probably the direct result of the very warm and excessively salt water it inhabits, it seems hardly necessary to give it sectional rank. The colors of the shell, apart from those of the periostracum, are usually white and purple; a Florida species is marked also with a zigzag pattern of brown, sometimes broken up into dots. The Pacific coast *A. subimbricata* forms a transition towards *Chione*. The left posterior and right anterior cardinals in the type are feeble; the latter in the oriental species is frequently obsolete, so that the valve appears to have but two cardinal teeth. The genus may be divided into the following sections:

Section *Anomalocardia* Schumacher. Type *Venus flexuosa* Linné.

Surface with predominantly concentric sculpture, vernicose periostracum, and the adjacent surfaces of the posterior left cardinal and right nymph minutely rugose. Distribution American and west African.

Section *Anomalodiscus* Dall. Type *Cytherea squamosa* Lamarck.

Surface with reticulate sculpture, the radials and concentric ridges subequal, a dull, papery periostracum, and the hinge without rugosities. Distribution, Indo-Chinese.

Anomalocardia floridana Conrad.

PLATE 55, FIGURES 14, 15.

Venus floridana Conrad, Am. Journ. Science, 2d Ser., ii., p. 400 (figure), 1846.
Venus penita (pars) Heilprin, Trans. Wagner Inst., i., p. 116, 1887.

Oligocene of the silex beds at Ballast Point, Tampa Bay, of the Sopchoppy limestone, and Bailey's Mill Creek sink, and of the Tampa limestone overlying the silex beds at Ballast Point, Florida.

This species is one of the most characteristic of those found in the silex beds, and as Conrad figured only a young, not very characteristic, specimen, and Heilprin did not figure it at all, it was thought best to give illustrations of it.

Conrad figures two species, the first and largest under the name of *Venus penita* (page 399) and the second *V. floridana.* I am somewhat inclined to think Heilprin was right in uniting them, but in a very large number of specimens I have found none which agrees precisely with Conrad's figure of *V. penita.* The identity of the common species of the silex beds with *V. floridana* is, however, undoubted, and therefore I have preferred to use that name, as Conrad's type of *V. penita* did not come from the silex beds, but was a cast in limestone, evidently the Tampa limestone, the next succeeding horizon. There is a chance that *V. penita* may turn up again and prove distinct from *V. floridana,* and it seems more prudent for the present to treat them separately.

The species is quite variable in form, as the following measurements will show:

Average adult	height	31.0,	length	38.0,	diameter	20.0 mm.
Elongated adult	"	25.0,	"	36.0,	"	20.0 mm.
Elongated young shell	"	20.5,	"	28.0,	"	15.0 mm.
Short young shell	"	19.0,	"	23.0,	"	15.0 mm.

When perfect the surface is finely, closely, sharply concentrically striated, the even sculpture broken here and there by resting stages. A faint reflection of radial striation sometimes appears towards the base on the most convex part of the disk. The beaks are low, pointed, and prosogyrate, the lunule cordate and striated, defined by an incised line. The escutcheon is bordered on each side by a strong, rounded keel, is slightly excavated and flattened, with the striation more feeble than on the disk; in front of the keels is a wide, shallow sulcus, corresponding to a concave flexuosity of the posterior base which more or less strongly rostrates the shell. The internal basal and anterior margins are finely crenulate; the pallial sinus is small and angular; the two larger right cardinals are feebly grooved. The external striation sometimes becomes a low lamellosity, the surface being harsh to the touch.

Anomalocardia penita Conrad appears to differ by a more slender and elongated shell, the posterior end of which shows hardly any flexuosity, but is extended like that of *A. caloosana,* while the lunular region is much less impressed than in *A. floridana.*

This form is not typical, but might be regarded as a precursor, in which *Anomalocardia* is developing from *Chione.*

Anomalocardia chipolana n. sp.

Plate 55, Figure 1.

Oligocene of the Chipola horizon at Alum Bluff, Calhoun County, Florida; Burns.

Shell small, trigonal, produced behind, sculptured with elevated concentric lines, more crowded towards the base; both lunule and escutcheon feebly defined, beaks low and pointed; hinge very delicate, normal, the internal margins faintly crenulate; both ends of the shell rounded, the base with hardly any flexuosity. Length 6.5, height 5.0, diameter 3.0 mm.

A single valve, perhaps young, was obtained and is named to fix the presence of the genus in these beds, from which it has been otherwise, so far, unknown.

Anomalocardia bowdeniana n. sp.

Plate 57, Figure 7.

Oligocene of the Bowden marl, Bowden, Jamaica.

Shell small, ovate-trigonal, subrostrate, with a flexuous base behind; beaks rather high, prosogyrate; lunule large, impressed, well defined, but with no defined escutcheon; posterior end pointed, anterior end rounded, base arcuate,

rather prominent mesially; surface sculptured with concentric striæ with flattish wider interspaces; hinge normal, rather heavy, inner margins entire; pallial sinus small, angular. Length 4.5, height 3.5, diameter 3.0 mm.

The small valve from which the above description is drawn up (the diameter as usual being twice the diameter of the valve) is up to the present time the sole representative of the genus known from the Bowden marl. It is doubtless immature.

Anomalocardia dupliniana n. sp.

PLATE 55, FIGURE 11.

Upper Miocene of the Natural Well, Duplin County, North Carolina; Burns.

Shell small, trigonal, high, with high, quite anterior beaks, the lunule and escutcheon not defined; anterior end rounded; posterior end produced, blunt; base moderately arcuate, not flexuous; surface smooth with feeble concentric striation, stronger posteriorly; hinge normal, feeble; inner margins entire; pallial sinus small, angular. Length 5.0, height 4.2, diameter 2.5 mm.

In this case also a single juvenile valve represents the genus in this horizon. In the older Miocene of Virginia and Maryland conditions were so much colder that it seems improbable that *Anomalocardia*, which is a tropical or subtropical genus, will ever be found.

Anomalocardia caloosana Dall.

PLATE 42, FIGURE 10.

Venus (*Anomalocardia*) *caloosana* Dall, Trans. Wagner Inst., iii., p. 1198, pl. xlii., fig. 10, 1900.

Pliocene of the Caloosahatchie beds, on the Caloosahatchie and Myakka Rivers and Shell Creek, Florida; Pleistocene of North Creek, near Osprey, Florida.

Shell elongate, with low, pointed beaks, the anterior end rounded and swollen, the posterior end compressed, attenuated, and rostrate; the posterior dorsal slope long and straight; the base convex and slightly flexuous behind; sculpture of concentric waves, not coincident with the lines of growth and steeper on their dorsal slopes; these frequently become enfeebled or obsolete between the middle of the shell and the radial ridge bounding the escutcheon; lunule defined by an impressed line, lanceolate and narrow; escutcheon striated, impressed, bounded by a radial ridge which extends from the beaks to the rostrum; hinge delicate, normal, the rugosities distinct when adult; basal

margin crenulate; pallial sinus obsolete, not passing in front of the posterior adductor scar. Length 28, height 20, diameter 14 mm.

While this species has its range of variation like others, its most prominent characteristic is the presence and persistence of the concentric sculpture, which in the great majority of specimens is continuous across the disk.

Anomalocardia brasiliana Gmelin.

Venus brasiliana Gmelin, Syst. Nat., vi., p. 3289, 1792 (syn. exclus.).

Venus flexuosa Born, Test. Mus. Vind., p. 62, pl. iv., fig. 10, 1780; not of Linné, Syst. Nat., ed. xii., p. 1131, 1767.

Cytherea macrodon Lamarck, An. s. Vert., v., p. 580, 1818.

Venus macrodon Deshayes, An. s. Vert., vi., p. 327, 1834; Hanley, Bio. Shells, p. 116, pl. ix., fig. 7, 1843; Sowerby, Thes. Conch., ii., p. 717, pl. clvi., fig. 88, 1853.

Cytherea lunularis Lamarck, An. s. Vert., vi., p. 580, 1818.

Venus lunularis Deshayes, An. s. Vert., vi., p. 327, 1834; Philippi, Abb. u. Beschr., i., p. 177, pl. iii., fig. 10, 1844.

Pliocene of the Caloosahatchie beds, at Shell Creek, south Florida, Willcox, rare; Pleistocene of the Antilles and of Brazil, south to Rio Grande do Sul; living from Wilmington, North Carolina, south to the West Indies and Rio Janeiro.

This is the common *Anomalocardia* of the West Indies and Brazil, usually labelled *A. flexuosa* after Born, but not the *Venus flexuosa* of Linné, which is an allied species and has been figured by Hanley in his monograph of the Linnean types.

The present species differs from *A. caloosana* in its short, inflated form, with the concentric sulci emphasized in front and on the posterior dorsal ridges, but absent in the middle of the shell. When fully adult it is a much heavier shell than *A. caloosana,* and the larger cardinals are much stouter, but in the young these differences are not so marked.

Genus **VENUS** (Linné) Lamarck.

< *Venus* Linné, Syst. Nat., ed. x., p. 685, 1758; ed. xii., p. 1128, 1767; Gmelin, Syst. Nat., p. 3266, 1792. First species *V. Dione* L.; Murray, Fund. Test., p. 148. pl. iii., figs. 11, 16, 17, 1771 (cites *V. dione* L. only); Scopoli, Intr. ad. hist. nat., p. 399, 1777 (cites no type); Bolten, Mus. Bolt., p. 125, 1798 (contains 44 species in two unnamed groups, including *V. mercenaria* and *V. dione* L., but mentions no type.

Pectunculus Da Costa, Brit. Conch., p. 184, 1778, *ex parte,* not of Lamarck, 1799.

= *Venus* Lamarck, Prodrome, p. 84, 1799; sole example *V. mercenaria* L.; Fischer, Man. de Conchyl., p. 1083, 1887.

Mercenaria Schumacher, Essai, pp. 45, 135, 1817 (*V. mercenaria* L.); Mörch, Yoldi Cat., ii., p. 23, 1853; Römer, Krit. Unters., p. 16, 1857; H. and A. Adams, Gen. Rec. Mol., ii., p. 419, 1857; Stoliczka, Cret. Pel. India, p. 153, 1871; Tryon, Syst. Conch., iii., p. 176, 1884.

Crassivenus Perkins, Proc. Boston Soc. Nat. Hist., xiii., p. 147, 1869 (*V. mercenaria* Linné).

Not *Mercenaria* Cossmann, Cat. Illustré, p. 94, 1887.

The genus *Venus*, as restricted, is a very compact and homogeneous group illustrating the highest development of the hinge-structure and the most extreme limit of size afforded by the genus in its widest sense. While not affording such exemplars of beauty in color and sculpture as the tropical groups contain, nevertheless the reputation of the species as a basis for Indian trade and a very important food supply is worthy of its distinction as type of the most characteristic product of evolution in the Pelecypoda.

The shell of *Venus* is solid and heavy, porcellanous, and somewhat earthy; the periostracum extremely thin and hardly visible; the form is rounded or trigonal with faint radial striation and stronger concentric lamellosity; the inner margins are crenulate; the pallial sinus is small and triangular; the beaks are prominent; the lunule and escutcheon well defined; there are two bifid cardinal teeth in the left valve; one posterior bifid and two anterior simple cardinals in the right valve; a supplementary posterior cardinal in each valve below the ligamentary nymph is modified to form a rugose area of which the asperities interlock with those of the opposite valve. The genus is represented on muddy or sandy bottom in shallow water from the north shore of the Gulf of Mexico to Cape Cod, with some still more northern colonies reaching the Gulf of St. Lawrence; a single species is found in the Oregonian region. The group appears first in the Oligocene and seems to have had its maximum development in the Miocene. As far as yet known it is confined to North America and Japan.

Venus halidona Dall.

PLATE 38, FIGURES 1, 1a.

Venus halidona Dall, Trans. Wagner Inst., iii., part v., p. 1194, pl. xxxviii., figs. 1, 1a, 1900.

Oligocene silex beds of Hillsboro' Bay and Ballast Point near Tampa, Florida; Dall, Burns, and Willcox.

Shell small for the genus, subovate, slightly truncate behind; beaks low, anteriorly directed over a rather large lanceolate lunule; posterior dorsal area narrow, nearly smooth, elongate, laterally keeled; sculpture of sharp, thin,

elevated, concentric lamellæ, slightly produced at their intersections with the posterior dorsal keels, the interspaces slightly striated by lines of growth without radial sculpture; hinge with three cardinals in each valve, the posterior right and middle left grooved or bifid; the rugose area narrow and inconspicuous but definitely present; pallial line with a short angular sinus; the inner border of the valves finely crenate. Height of a short and an elongate specimen respectively 32.5 and 34.0, length 34.0 and 40.0, diameter 22.0 and 20.0 mm.; concentric lamellæ 6 to 14 on a radial centimetre.

This small species appears fully adult and differs from the young of *V. Langdoni* in its more numerous, less prominent, and thinner lamellæ, which are not bent down and broadened on the posterior slope; the shell is also less trigonal. From an examination of numerous valves it appears to have much such a series of mutations in form as the larger species, though less pronounced. There seems to be no tendency to effacement of the lamellæ in the middle of the disk. It may be regarded as one of the precursors of the large species of the Miocene.

Venus Langdoni Dall.

PLATE 42, FIGURES 2, 7, 12.

Venus Langdoni Dall, Trans. Wagner Inst., iii., part v., p. 1198, pl. xlii., figs. 2, 7, 12, 1900.

Oligocene of the Chipola formation at Alum Bluff, Calhoun County, Florida; Dall and Burns.

Shell of moderate size, subtrigonal, inflated, with prominent decurved beaks and a large cordate lunule; posterior dorsal area large, laterally keeled, with coarse concentric striation, the dorsal margin of the right valve somewhat overlapping that of the left; sculpture of numerous rather distant, thick, elevated, concentric recurved ribs, which on the posterior part of the disk are bent downward and expanded; the interspaces are closely, sharply, deeply, concentrically striated, so that the interspaces of the striæ are almost lamellose; owing to the general slight decortication the internal radial structure of the shell is usually more or less visible, though in a perfectly intact specimen it would be completely hidden; hinge as in the other species, the rugose area in the adult large and prominent; pallial line with a short angular sinus; the inner anterior and basal margins of the valves finely crenulate. Height 70, length 88, diameter 50 mm.

This fine species is named in honor of D. W. Langdon, Jr., who has done much work on our Southern Tertiary.

The species is distinguished by its heavy, prominent, recurved concentric

ribbing from any of the other species of the genus, recalling in this respect some of the forms of *Chione*. It has so far been obtained only from the lower or Chipolan bed at Alum Bluff, where it is rather abundant.

Venus Ducateli Conrad.

Venus Ducateli Conrad, Fos. Medial Tert., p. 8, pl. iv., fig. 2, 1838; Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Whitfield, Mioc. Moll. N. Jersey, p. 67, pl. xi., figs. 1, 2, 3 (only), 1895.

Miocene of Cumberland County, New Jersey, and near Church Hill, Maryland; Harris.

This species differs from *V. mercenaria* by having solid, thick, elevated ribs, more or less recurved, and expanded and more elevated after they pass upon the posterior dorsal area. The corrugated area of the hinge is relatively small compared with that of *V. mercenaria,* which is probably the reason why Conrad left the species in *Venus* while putting the allied forms in *Mercenaria* in 1863. Mr. Whitfield very properly called attention to the fact that *V. Ducateli* was congeneric with *V. mercenaria.* However, part of the decorticated material which he doubtingly included under this name, and which is represented by his figures 4, 5, 6, and 7, belongs to another species, *V. plena.*

Venus plena Conrad.

Mercenaria plena Conrad, Am. Journ. Conch., v., p. 100, 1869; Whitfield, Mioc. Moll. N. Jersey, p. 69, pl. xii., figs. 4–6, 1895.

Venus Ducateli Whitfield (*ex parte*), *op. cit.,* pl. xi., figs. 4–7, 1895.

Venus plena Heilprin, Proc. Acad. Nat. Sci. Phila. for 1887, pp. 397 and 403.

Older Miocene of Cumberland County, New Jersey, at Shiloh and Jericho; of Plum Point, Maryland; Miocene of Virginia on the York River, near Bellefield and Yorktown, and of North Carolina at Wilmington.

This is a small but often quite thick and heavy species, of which the most abundant mutation found near Yorktown is a flattish oval shell which suggests a dwarf *V. Rileyi,* but which passes into a thinner and more inflated form, such as those figured by Whitfield from New Jersey. The maximum length which I have noted among the specimens in the National Museum is seventy-five millimetres. The shell has a much smaller rugose area on the hinge than is found in *V. mercenaria* of the same size. When the sculpture is intact, which rarely occurs, it exhibits close-set, thickish, rather low concentric lamellæ. None show any smooth medial area or thickened ribs, except when part of the surface is deficient. In outline the species passes through much such a series

of mutations as *V. mercenaria,* though the normal form appears to be rather regularly oval and only moderately convex. A variety which may be called *inflata* is more trigonal and measures 60 mm. long, 55 mm. high, and 36 mm. in diameter. It is from Bellefield, York River, Virginia. Another form which I found mixed with the type at the same locality, and at first thought might be distinct, is rounded, subtruncate behind, very thick for its size, the surface slightly undulate and with the lamellation obsolete. It may take the name of variety *nucea.* It measures: length 33, height 29, and diameter 16 mm. The measurements of a normal, oval specimen from Shiloh, New Jersey, are: length 68, height 55, and diameter 24 mm. A more inflated, thin specimen from Maryland measures: length 75, height 61, diameter 36 mm.

Venus tridacnoides Lamarck.

Cyprina tridacnoides Lamarck, An. s. Vert., v., p. 558, 1818; after Lister, Conch., pl. ccccxcix., 1692.

Venus tridacnoides Deshayes, An. s. Vert., ed. ii., vi., p. 591, note, 1835; Conrad, Fos. Medial Tert., p. 10, pl. vii., fig. 2, 1838; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 85, pl. xxii., fig. 1, 1857; Emmons, Geol. Rep. N. Car., p. 292, 1858.

Venus deformis Say, Journ. Acad. Nat. Sci. Phila., iv., p. 148, pl. xii., fig. 2, 1824; Morton, Syn. Org. Rem., App., p. 2, 1834.

Venus difformis Emmons, Geol. Rep. N. Car., p. 292, 1858.

Mercenaria tridacnoides Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864.

Venus Rileyi Conrad, Fos. Medial Tert., p. 9, pl. vi., fig. 1, 1838; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 78, pl. xxi., fig. 8, 1857; Emmons, Geol. Rep. N. Car., p. 292, 1858; Heilprin, Trans. Wagner Inst., i., p. 102, 1886.

Mercenaria Rileyi Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864.

Mercenaria percrassa Conrad, Am. Journ. Conch., iii., p. 13, 1867; iv., p. 278, pl. xix., fig. 1, 1868.

Miocene of Maryland at Plum Point; of Virginia at Petersburg; City Point and Grove Wharf on the James River; the York River at Yorktown, Bellefield, Temple Place, and Gloucester Point; Hanover and Suffolk; of North Carolina at the Duplin County Natural Well and Magnolia; in Edgecombe County and at Wilmington; of South Carolina at and near Darlington; of Florida at Darling's Slide, Calhoun County; the upper bed at Alum Bluff, at Jackson Bluff, and sixteen miles southwest of Tallahassee; Pliocene of the Waccamaw River, South Carolina, and of the Caloosahatchie and Shell Creek, Florida; Pleistocene of Heislerville, Cumberland County, New Jersey(?).

This is a remarkable species first named in 1818 by Lamarck from a pathological mutation figured by Lister, and renamed by Say six years later. The normal and healthy form of the species was not named until 1838, when Conrad called it *V. Rileyi,* while his last name, *V. percrassa,* was given to a particular form of the pathological monstrosity. It is impossible to determine the precise cause of the deformity and hypertrophy of the peculiar individuals. Such have been found from the York River, Virginia, to Darlington, South Carolina, though the normal form, *V. Rileyi,* has a much wider range. I have seen a few specimens of *V. Mortoni* and *V. mercenaria* similarly affected, and in recent shells the access of an excess of fresh water sometimes produces similar abnormal characters. However, *V. tridacnoides* seems to have been peculiarly liable to this deformity. The species may be divided as follows:

Venus tridacnoides Lamarck:

A. Variety *tridacnoides* s. s.

This includes *deformis* Say and *percrassa* Conrad.

B. Variety *Rileyi* Conrad.

This is the normal form of the species.

The shell from the Post-Pliocene beds at Heislerville may perhaps be a mutation of *V. mercenaria* towards the *Rileyi* type. If this be eliminated, the species may be regarded as restricted to the Miocene and Pliocene, being comparatively rare in the beds of the later age.

Venus mercenaria Linné

<*Venus mercenaria* Linné, Syst. Nat., ed. x., p. 686, 1758; Fauna Suecica, p. 519, 1761; Syst. Nat., ed. xii., p. 1131, 1767; Gmelin, Syst. Nat., vi., p. 3271, 1792; Dillwyn, Cat. Rec. Sh., i., p. 176, 1817 (cf. Lister, Hist. Conch., pl. cclxxi., fig. 107, 1692).

Venus mercenaria Spengler, Schrift, Berl. Ges. Naturf. Freunde, vi., p. 307, pl. vi., figs. 1, 2, 3, 1785; Chemnitz, Conch. Cab., x., p. 352, pl. clxxi., figs. 1659, 1660, 1788; Lamarck, Prodrome, p. 84, 1799; An. s. Vert., v., p. 591, 1818; Akerly, Am. Monthly Mag., ii., p. 296, 1818; Say, Journ. Acad. Nat. Sci. Phila., ii., p. 271, 1822; Wood, Ind. Test., p. 35, pl. vii., fig. 40, 1825; Mitchill, Am. Journ. Sci., 1st Ser., x., p. 287, 1826; Conrad, Journ. Acad. Nat. Sci. Phila., vi., p. 209, 1830; Greene, Mass. Cat., 1833; Gould, Inv. Mass., p. 85, fig. 67, 1841; Deshayes, Enc. Méth. Vers., iii., p. 1117, pl. cclxxiii., 1832; Lamarck, An. s. Vert., ed. ii., vi., p. 346, 1835; Mighels, Boston Journ. Nat. Hist., iv., p. 320, 1843; Stimpson, Shells of N. Eng., p. 19, 1851; Sowerby, Thes. Conch., ii., p. 733, pl. clxii., figs. 204–206, 1853; De Kay, Zool. of New York, v., p. 217, pl. xxvii., fig. 276, 1843; Reeve, Conch. Icon., xiv., Mon. *Venus,* pl. ii., fig. 46, 1863;

Binney's Gould's Inv. Mass., p. 133, fig. 52, 1870; Verrill, Inv. An. Viney. Sd., p. 681, pl. xxvi., fig. 184, 1873; Dall, Bull. 37 U. S. Nat. Mus., p. 54, pl. lv., fig. 7, pl. lxxi., figs. 1, 3, 1889.

Pectunculus mercenarius Da Costa, in Cat. Calonnianum, p. 48, No. 911, 1797.

Venus meretrix Bolten, Mus. Bolt., p. 126, No. 287, 1798; not of Linné, 1758.

Mercenaria violacea Schumacher, Essai, p. 135, pl. x., fig. 3, 1817; Deshayes, Cat. Conch. Brit. Mus., p. 113, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 419, 1857; Holmes, Post-Pl. Fos. S. Car., p. 33, pl. vi., fig. 11, 1858.

Mercenaria mercenaria Mörch, Cat. Yoldi, ii., p. 23, 1853; Chenu, Man. Conch., ii., p. 82, figs. 356, 357, 358, 1862; Tryon, Am. Mar. Conch., p. 158, figs. 388–90, 1874; Syst. Conch., iii., p. 176, 1884.

Crassivenus mercenaria Perkins, Proc. Boston Soc. N. Hist., xiii., p. 147, 1869.

Pectunculus fasciatus, Binney's Gould's Inv. Mass., p. 134, note, 1870.

Mercenaria cancellata Gabb, Journ. Acad. Nat. Sci. Phila., 2d Ser., iv., p. 376, pl. lxvii., fig. 25, 1860; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Whitfield, Miocene Fos. N. J., p. 68, pl. xii., figs. 2, 3, 1895; not *Venus cancellata* Linné, 1758.

Venus mercenaria var. *antiqua* Verrill, Am. Journ. Sci., 3d Ser., x., p. 371, 1875; not *Venus antiqua* King, 1831.

Venus mercenaria var. **notata** Say.

Venus notata Say, Journ. Acad. Nat. Sci. Phila., ii., p. 271, 1822; De Kay, Zool. N. Y., v., p. 218, pl. xxvii., fig. 278, 1843; Philippi, Abb. u. Beschr. Conch., i., p. 128, pl. ii., fig. 3, 1844; Mighels, Bost. Journ. Nat. Hist., iv., p. 320, 1843; Reeve, Conch. Icon., xiv., *Venus,* pl. ii., fig. 4a, 1863; Binney's Gould's Inv. Mass., p. 135, fig. 446, 1870; not of Gould, Inv. Mass., pl. iv., fig. 67, lower outline.

Venus obliqua Anton, Archiv für Naturg., 1837, i., p. 284.

Venus cyprinoides Anton, Verz. Conch., p. 9, 1839.

Cytherea notata Mörch, Cat. Yoldi, p. 23, 1853.

Mercenaria notata Deshayes, Cat. Conch. Brit. Mus., p. 114, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 419, 1857; Holmes, Post-Pl. Fos. S. Car., p. 33, pl. vi., fig. 11, 1858.

Fossil in the older Miocene of the Choptank River, Maryland, and subsequently in the Miocene of Gay Head, Martha's Vineyard, Massachusetts, and of Maryland, Virginia, and Florida; in the Pliocene of the Carolinas and Florida; in the Pleistocene of Sankoty Head, Nantucket, Massachusetts; of Rhode Island; Wailes Bluff, near Cornfield Harbor, Maryland; Simmons Bluff, South Carolina, and many other localities on the Atlantic coast of the United States.

Living from the Bay of Chaleur, Gulf of St. Lawrence, locally, in various

places to Cape Cod, southward to the Florida Keys, and westward to the Texas coast, where it is rare. The variety *notata* has been collected from New England to Georgia. It has been introduced into British seas.

The remarks and synonymy connected with this species by Linné, Pennant, Dillwyn, and other early writers indicate some confusion of it with *Venus* (= *Cyclas*) *islandica,* and a consequent extension of its distribution to northern Europe. Later this was cleared up. In studying the recent specimens to obtain light on their fossil predecessors, I came to the conclusion that two species can be distinguished, with different ranges of distribution, and which have an analogous series of mutations and very possibly, in the region where both occur, occasionally hybridize.

V. mercenaria in its typical form is more produced and pointed before and especially behind; it has the concentric sculpture obsolete on the middle of the disk, where the shell is often tinted with ferruginous brown and, if living in mud, with bluish black. The lunule and escutcheon are not differently colored from the rest of the shell. The pallial sinus was regarded by Stimpson as shallower than in *V. campechiensis,* and its ventral boundary usually makes a more obtuse angle with the pallial line, though I do not find the differences in this respect very marked. The purple coloring when present is marginal, and some trace of it almost always persists on the dorsal posterior margin. In the young over an inch long the shell is rounder and more convex than in *campechiensis* of the same age, while in the adults these characters are reversed. In the very large series of specimens which I have studied the crenulation of the margin in *V. mercenaria* seems to me to be quite constantly coarser than in *V. campechiensis* of the same size.

The shell grows rather slowly. In specimens "planted" in a favorable locality in September, 1879, the median radius was 31.0 mm.; in the following April 32.5 mm.; in June, 1880, 35.0, and in September, 1880, 45.0 mm. This shows a growth in one year of 14.0 mm., most of which took place between June and September. Judging by the incremental irregularities, a specimen with a median radius of 115.0 mm. from the summit of the beaks to the middle of the base (measured in a straight line on the inside of the shell) was about ten years old.

The dimensions of a fully grown normal specimen are as follows: length 133, height 104, diameter 50 mm.

The observed mutations are as follows:

1. Closer or more distant concentric lamellation.
2. Rounder or more cuneate form.

3. Concentric interspaces smooth or radially striated, the striation sparse, irregular, or local in situation, or general, but always very fine.
3. The presence or absence on the disk of zigzag brown blotches or lineation.
4. The greater or less conspicuousness of an obscure radial sulcus near the posterior dorsal border.
5. The presence or absence of the internal marginal purple coloration.
6. The division of the medial smooth space by concentric sulci into more or less numerous riblike flattened ridges, which may be smooth or radially grooved; white or having the *notata* coloration; even and uniform or more or less bifurcate or inosculated distally, but always flattened, except in the fossil variety *antiqua*.

The varieties which may be usefully named are: 1, variety *notata* Say, which, in addition to the usual characters, shows zigzag brown painting, especially over the smooth middle portion of the disk, and is usually destitute of purple coloration within; 2, variety *radiata* Dall, in which the disk shows between the concentric lamellæ fine, even, radial striation; 3, variety *alba* Dall, in which the purple coloration is absent, and there are no brown external markings as in *notata;* 4, variety *cancellata* Gabb, a rare form in which the median flattened portion is cut into flattish ribs by the continuation across the shell of some of the concentric sulci, while these are transversely grooved by radial sculpture, as in variety *radiata*.

Considering the number of mutable elements in this species and *V. campechiensis,* the number of combinations which might be found by sufficiently extensive collecting is obviously very great. But it seems as if science would not profit particularly by devising names for them all. I may note that most of the mutations occur both recent and fossil and are not confined to a special horizon, though they are perhaps due in most cases to especial conditions of water, salinity, temperature, food, or character of the bottom. While it is impossible to cite characters which will invariably distinguish all the varieties and mutations of *V. mercenaria* from those of *V. campechiensis,* nevertheless in general they are separable by sufficiently obvious features which apply to both the Miocene fossils, the recent shells, and their intermediate representatives.

I have found the most remarkable mutations in the specimens from the Pleistocene, which may perhaps be due to the changes initiated by the fluctuations of temperature and salinity connected with glaciation.

In specimens from Heislerville, New Jersey, I find some with strong con-

centric sulci across the middle part of the disk, the flat and polished interspaces still showing traces of brown painting like *notata*. In a specimen 90 mm. long, the vertical from the beaks falls only 7 mm. behind the front edge of the valves; in another from the same locality 80 mm. long, the same vertical is 20 mm. behind the front edge. In a specimen of the common or typical form 80 mm. long, the vertical falls at about 15 mm.

In specimens from the Pleistocene of Sankoty Head, Nantucket Island, Massachusetts, we find every gradation of concentric sculpture, from those with the normal medial smooth area to others with close, fine, sharp, concentric lamellæ entirely covering the shell, forming Verrill's variety *antiqua*, which, so far as I have observed, is never paralleled among the recent shells.

These differences result in very different-looking shells, and it would be easy to select a considerable number of individuals with characters which, if constant, would be regarded as specific; consequently it is not unreasonable to view with a lenient eye the work of Conrad and others based on a few specimens, by which the specific names have been unduly multiplied.

Venus campechiensis Gmelin.

Venus campechiensis Gmelin, Syst. Nat., v., p. 3287, 1792 (after Lister, Hist. Conch., pl. cclxxxiii., fig. 121, 1692); not of Dillwyn, Descr. Cat. Rec. Shells, i., p. 189, 1817.

Venus præparca Say, Journ. Acad. Nat. Sci. Phila., ii., p. 271, 1822; Binney's Say, p. 95, 1858.

Venus præopaca De Kay, Zool. N. Y., v., p. 219, 1843, *ex parte*.

Venus præparea Sowerby, Thes. Conch., ii., p. 733, pl. clxi., fig. 200, 1853.

Venus Mortoni Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 251, 1837; De Kay, Zool. N. Y., v., p. 219, 1843; Conrad, Am. Journ. Sci., 2d Ser., ii., p. 42, 1846; Reeve, Conch. Icon., xiv., Mon. *Venus*, pl. iii., fig. 7, 1864 (in errata).

Mercenaria Mortoni Deshayes, Cat. Conch. Brit. Mus., p. 114, 1853; Conrad, Proc. Acad. Nat. Sci. Phila., vii., p. 29, 1854; H. and A. Adams, Gen. Rec. Moll., ii., p. 419, 1857; Holmes, Post-Pl. Fos. S. Car., p. 34, pl. vi., fig. 12, 1858; Tryon, Am. Mar. Conch., p. 138, figs. 391–2, 1874.

Mercenaria præparca Deshayes, Cat. Conch. Brit. Mus., p. 115, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 419, 1857.

Venus calcarea Philippi, Abbild. u. Beschr. Conch., i., p. 175, *Venus*, pl. iii., fig. 1, 1844 (young shell).

Chione calcarea Deshayes, Cat. Conch. Brit. Mus., p. 123, 1853.

Venus tenuilamellata Sowerby, Thes. Conch., ii., p. 733, pl. clxi., fig. 195, 1853 (young shell).

Venus alboradiata Sowerby, Thes. Conch., ii., p. 732, pl. clxi., fig. 199, 1853; Reeve, Conch. Icon., xiv., Mon. *Venus*, pl. iii., fig. 7, 1863.

Mercenaria fulgurans Tryon, Am. Journ. Conch., i., p. 297, pl. xxvi., figs. 1–3, 1865 (young shell).

Venus tetrica Conrad, Fos. Medial Tert., p. 7, pl. iv., fig. 1, 1838; Bull. Nat. Inst., ii., p. 187, 1842.

Mercenaria tetrica Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864.

Venus permagna Conrad, Fos. Medial Tert., p. 9, 1838; Proc. Acad. Nat. Sci. Phila., i., p. 324, 1844; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 86, pl. xxii., fig. 2, 1856.

Mercenaria permagna Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864.

Venus capax Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 324, 1844; Fos. Medial Tert., p. 68, pl. xxxviii., fig. 4, 1845.

Mercenaria capax Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Meek, Checkl. Miocene Fos., p. 9, 1864.

Venus submortoni Orbigny, Prodr. Pal., iii., p. 208, 1852.

Mercenaria submortoni Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 574, 1863; Meek, Checkl. Mioc. Fos., p. 9, 1864.

Mercenaria obtusa Conrad, Am. Journ. Conch., ii., p. 104, pl. viii., fig. 3, 1866; not *Venus obtusa* Sedgwick and Murchison, 1844.

Mercenaria cuneata Conrad, Am. Journ. Conch., iv., p. 278, pl. xx., fig. 1, 1868.

Mercenaria carolinensis Conrad, in Kerr. Geol. Rep. N. Car., App., p. 20, 1875.

Miocene of Maryland and Virginia, the Carolinas and Florida; Pliocene of the Brunswick Canal, Georgia, and of Shell Creek, Florida; Pleistocene of South Carolina, Florida, and the shores of the Gulf of Mexico; living from Chesapeake Bay southward to Cuba, westward to Texas and Yucatan in moderate depths of water.

Careful study of a large series of recent specimens leads to the formulation of the following characters as distinctive of this species:

The adult shell is shorter, rounder, larger, and much thicker than that of *V. mercenaria;* it is usually wholly white internally; the lunule is wider than in *V. mercenaria,* the escutcheon better defined and wider, the disk wholly covered with fine, close lamellation, which is not obsolete on the middle of the valves nor colored red-brown or black; the lower posterior angle of the pallial sinus is generally more acute, the crenulation of the inner margin finer, and the disposition of the cardinal teeth less fan-like than in *V. mercenaria.*

The young shell is less convex than in the other species, as a rule, and is almost invariably white, with a brown lunule and escutcheon, and fine, pale-brown zigzag lines * or pale alternating with brown rays showing through the

* In this state it forms the *V. fulgurans* of Tryon.

lamellation: the shell is frequently subtruncate behind or more or less quadrate; internally the margin is always white, but sometimes in the cavity of the beaks a pretty, pale-purple suffusion is seen, which no specimen of *V. mercenaria* is known to exhibit. The brown zigzags are distinctly linear, while in *V. mercenaria* they are broader and more or less blotchy.

The mutations are much the same as in *V. mercenaria* except that the middle of the disk is never wholly smooth, the lamellæ are usually continuous, and the change, if any, in the middle of the shell consists in broadening the lamellæ themselves, on the polished tops of which the brown painting will appear with great distinctness. In full-grown specimens the lamellæ are always pretty close set, but in the young they may be fine and close, or coarse and distant. The posterior radial sulcus in senile specimens is strong. Occasionally an adult shows traces of purple coloration at the margin, which may be due to hybridity, but I have never seen any specimens with the other characters of *V. campechiensis* which had the dark purple border of the typical *V. mercenaria.*

The measurements of a fully adult specimen are as follows: length 133, width 117, diameter 82 mm.

The species is not positively known to be now represented north of Chesapeake Bay; it is the prevalent type beyond the Mississippi delta on the Texas coast, and the only one yet reported from Yucatan, where Schott collected it abundantly. It was from this region that Lister's adolescent shell, which served as Gmelin's type, was originally obtained. Varieties may be distinguished as follows: 1, variety *alboradiata* Sowerby, with brownish rays on a paler ground; 2, variety *quadrata* Dall, with the shell thin, small, compressed, subquadrate, and unicolorate; 3, variety *texana* Dall, with the concentric lamellæ towards the middle of the disk coalescent, forming broad, more or less inosculating, flat-topped ribs with polished tops; the valves usually very convex. Numerous names have been given by Conrad to the mutations of the fossil form, many of which mutations can be found in a large collection of the recent shells. Of these *V. tetrica* Conrad is large, subtrigonal, rather moderately convex, and with less prominent beaks than the type, but it has the close, fine lamellation of the typical *V. Mortoni,* which is the fully adult *V. campechiensis. V. permagna* Conrad is ovate instead of trigonal and rather longer and less inflated than the type, with some of the lamellæ thickened medially; *V. capax* Conrad is the suborbicular and ventricose young of *V. Mortoni* which have passed the subquadrate stage. The name of *V. submortoni* was substituted for *V. Mortoni* Conrad by Orbigny because the latter included

Cytherea Lamarck in the genus *Venus* and there was a *Cytherea Mortoni* of Conrad from the Eocene. *V. obtusa* Conrad (a preoccupied name) is a pathologically stunted and thickened shell of the species under discussion, and *Mercenaria cuneata* Conrad is an exceptionally short *V. Mortoni,* forming the extreme in brevity which contrasts with *V. tetrica,* which is the most elongated mutation. *Mercenaria carolinensis* Conrad is an average, moderate-sized shell with the form of *V. permagna* and some thickening of the lamellæ medially. This also occurs in the recent state.

The following names have been given to the quite young shell, not over two inches in length: *Venus calcarea* Philippi, *V. tenuilamellata* Sowerby, and *V. fulgurans* Tryon, all of the suborbicular type.

Genus **MARCIA** H. and A. Adams.

Marcia H. and A. Adams, Gen. Rec. Moll., ii., p. 423, Feb., 1857; not of Chenu, 1862, or Tryon, 1884.

<*Katelysia* Römer, Krit. Unters., p. 17, May, 1857; *Venus exalbida* Chemnitz, *V. scalarina* Lamarck.

Murcia (pars) Römer, Krit. Unters., p. 16, 1857; not *Murcia* Koch, *Arachnida,* 1835.

>*Katelysia* Tryon, Syst. Conch., iii., p. 177, 1884 (*V. scalarina*).

>*Catelysia* Fischer, Man. de Conchyl., pp. 1084, 1086, 1887.

Marcia Fischer, Man. de Conchyl., p. 1086, 1887 (*V. exalbida*); not of Chenu, 1862.

>*Hemitapes* Römer, Mal. Blätt., xi., p. 83, 1864, type *Venus rimularis* Lamarck (as *V. virginea* L.); Mon. *Venus,* ii., p. 97, 1872; = *Pullastra* (sp.) Mörch, Cat. Yoldi, ii., p. 21, 1853; not *Hemitapes* Stoliczka, Cret. Pel. India, p. 144, 1871, or Tryon, Syst. Conch., iii., p. 182, 1884, or Fischer, Man. de Conchyl., p. 1086, 1887 (*Venus pinguis* Dillwyn).

>*Chamelea* Chenu, Man. de Conchyl., ii., p. 81, 1862 (*Venus aphrodinoides* Lamarck); not of Mörch, 1853, or Römer, 1857.

>*Textivenus* Cossmann, Cat. Illustr., i., p. 97, 1886 (*Venus texta* Lamarck); Fischer, Man. de Conchyl., p. 1087, 1887.

>*Mercenaria* Cossmann, Cat. Illustr., i., p. 94, 1886; not of Schumacher, 1817.

>*Venerella* Cossmann, Cat. Illustr., i., p. 93, 1886, *Venus hermonvillensis* Deshayes; Fischer, Man. de Conchyl., p. 1087, 1887.

Chione and *Tapes* (sp.) Deshayes, Cat. Conch. Brit. Mus., i., p. 147–50, etc., 1853.

The synonymy of this group is so mixed that hardly any rearrangement can be suggested which is not open to some criticism. After much cogitation the following *schema* appears to be the least objectionable of any that has appeared to be feasible at all.

Marcia was proposed, as a subgenus of *Chione* Mühlfeld, by H. and A.

Adams in February, 1857. It was a heterogeneous group, most of the species ranking with the earlier *Gomphina* of Mörch. Three months later Römer proposed, for a group represented by one of Adams' species of *Marcia* and another referred to *Chamelea* by Adams, the name of *Katelysia*. The first to accept this name was Tryon in 1884, who selected *V. scalarina* Lamarck as type of Römer's group, in which he was followed by Fischer, who changed the name to *Catelysia*. Chenu, in 1862, and Tryon took as an exemplar of *Marcia* Adams *Venus undulosa* Lamarck, which was already the type of *Gomphina* Mörch, and not available for the later *Marcia*. Fischer in his "Manuel de Conchyliologie" cited *Venus exalbida* Chemnitz (which was included by the Adams brothers in *Marcia*, though it does not agree with their diagnosis, the surface not being smooth) as the type of *Marcia*, and it is probably best to accept this rather than make another change on account of the discrepancy alluded to, which may have been due to the worn condition of their specimen.

In 1864 Römer proposed *Hemitapes* for a group typified by *Venus rimularis* Lamarck, which he referred to *V. virginea* Linné, a name appropriated, following Hanley's investigation into the Linnean types, for the *Tapes virgineus* of Europe. But Stoliczka, Tryon, and Fischer by some error cited *Venus pinguis* of Dillwyn (after Chemnitz), a species of *Gomphina*, as the type of *Hemitapes*. The other names cited in the preceding synonymy are of related groups which will find their places in the arrangement hereafter following. Several of Cossmann's sections placed with *Tapes* by Fischer seem more appropriately put with the Venerid forms, as Cossmann originally proposed. Of the original *Marcia* of Adams the group typified by *Venus quadrangularis* Adams and Reeve appears still to need a sectional designation.

The group as treated here will comprise the *Veneridæ* of subquadrate or trigonal form which occupy the place in the *Venerinæ* that is taken in the *Meretricinæ* by *Pitaria* and *Meretrix*, which they much resemble except for the differences of the hinge. The soft parts appear to be unknown, and the group is rather characteristic of the southern hemisphere, especially the Australasian seas, though a few species reach the tropics of the northern hemisphere, where they seem to have been more numerous in Tertiary times. The normal dental formula is $\frac{\text{L. } 101010.}{\text{R. } 010101.}$.

Subgenus *Marcia* (Adams) Fischer. Type *Venus exalbida* (Chemnitz) Dillwyn.

Shell large, earthy, with a dull surface sculptured with concentric lamellæ and finer concentric striation; there is no radial sculpture; the lunule is large

and sharply circumscribed by an incised line; there is no defined escutcheon; the ligament strong and elongated, fully exposed; the pallial sinus is small, pointed in front, horizontal, and free from the pallial line below; the inner valve margins are smooth in the type. The dental formula is $\frac{\text{L. } 0101010.}{\text{R. } 1010101.}$. The posterior right cardinal is slender but distinct; the two in front of it and the middle left cardinal are feebly bifid. The type recalls *Mercenaria* and some species of the *Callithaca* group of *Paphia*. It is a native of the shores of South America both on the Atlantic and Pacific.

Subgenus *Katelysia* (Römer) Tryon. Type *Venus scalarina* Lamarck.

Shell rounded trigonal, very inequilateral, subcompressed, sculptured with concentric riblike ridges, sharper distally, polished, porcellanous, with an inconspicuous periostracum; there is no radial sculpture; coloration lively; the anterior end shorter; lunule circumscribed and, with the undefined escutcheon, smooth; ligament short; pallial sinus short, ascending, free below, blunt or rounded in front; teeth concentrated, the anterior right and posterior left cardinals slender, entire, the others grooved or bifid; internal margins of the valves smooth; hinge-plate buttressed between the pedal scar and the scar of the anterior adductor.

The inequilateral ovate form of these shells is quite striking. The dental formula is normal. *Chamelea* Chenu, not Mörch, is synonymous.

Section *Katelysia* Römer (*vide supra*).

Section *Hemitapes* Römer. Type *Venus rimularis* Lamarck.

Shell subtrigonal, very tumid, otherwise essentially as in *Katelysia*, though the aspect of the shells is very different on account of the difference in form.

Section *Venerella* Cossmann. Type *Venus hermonvillensis* Deshayes.

Shells small, concentrically striate, ovate; the lunule rather large, circumscribed; the escutcheon not defined, internal margins entire; the pallial sinus small, ascending, free below, rounded in front; three teeth in each valve, the edge of the hinge-plate excavated at the spaces between them; the posterior left cardinal long, bifid, the other teeth entire, the formula normal.

These are distinguishable from the smaller species of *Katelysia* chiefly by the form and disposition of the teeth.

Section *Mercinonia* Dall, 1902. Type *Venus Bernayi* Cossmann, Cat. Illustré, i., p. 95, pl. vi., figs. 11–13.

Shell small, ovate, concentrically striate, rather tumid; hinge normal, the

posterior left cardinal not so disproportionately long, slender; the posterior right cardinal grooved; margins entire; the pallial sinus nearly obsolete.

This is *Mercenaria* Cossmann, 1886, not of Schumacher, 1817. The coarse hinge-rugosities and crenulated margin of the true *Mercenaria* have no parallel here. The species which are included in Cossmann's list and have a deep though small sinus might be referred to the preceding section, from which they hardly differ.

Section *Textivenus* Cossmann. Type *Venus texta* Lamarck. Parisian Eocene.

Shell ovate, moderately convex, the surface sculptured by fine, obliquely reticulate or divaricate, subequal, thread-like ridges; lunule small, circumscribed; escutcheon bordered by a radial ridge; internal margins smooth, the right posterior dorsal margin behind the hinge-plate grooved to receive the bevelled edge of the opposite valve; teeth normal, the posterior right cardinal broadly bifid; pallial sinus small, angular, free.

Section *Samarangia* Dall, 1902. Type *Venus quadrangularis* Adams and Reeve.

Shell rounded quadrate, subcompressed, with an impressed lunule; sculpture of concentric striation more forcible distally; hinge solid, normal, the two right posterior cardinals bifid; the pallial sinus small, the inner margins of the valves smooth.

This type includes *Venus lenticularis* Sowerby, and the shell is massive and solid.

The only representatives of *Marcia* in the North American Tertiary are *M. subdiaphana* Carpenter, described as a *Clementia*, and which, according to Cooper, occurs in the Pliocene of San Diego, California, and the Pleistocene of the California coast at several localities. The *Tapes gibbosus* of Gabb has a very similar appearance externally, and may probably also be referable to *Marcia*. It is found in the Miocene of Coos Bay, Oregon, horizon of the Empire beds, and also in the Miocene of Mendocino County, California.

Genus **PAPHIA** Bolten.

<*Paphia* Bolten, Mus. Boltenianum, p. 175, 1798, ed. ii., p. 122, 1819; not *Paphia* Lamarck, 1799 and 1801, or Fabricius, 1808, or Oken, 1815.

Tapes Megerle v. Mühlfeld, Entw. neuen Syst. der Schälth. in Mag. Ges. Naturf. Freunde, p. 51, 1811 (*Venus literata* L.).

Venerupis (sp.) Lamarck, An. s. Vert. v., pp. 506–7, 1818.

Venus (sp.) Lamarck, *op. cit.*, pp. 597, 600, 1818; Brown, Ill. Conch. Gt. Brit., expl. pls. xix., xx., 1827.

Tapes Schumacher, Essai, pp. 45, 136, 1817 (Sect. α, *Venus alapapilionis* Chemn.; Sect. β, *V. decussata* L.).

Pullastra Sowerby, Gen. Shells, fasc. xxviii., 1826; no type cited; Zool. Journ., iii., p. 134 (*V. pullastra*), 1827.

Cuneus (sp.) Da Costa, Brit. Conch., p. 202, 1778; not of Da Costa, Elém. Conch., 1776 (= *Trigonia*), nor *Cuneus* Deshayes, 1853.

Tapes Gray, List Brit. An. Brit. Mus., p. 12, 1851; Deshayes, Cat. Conch. Brit. Mus., i., pp. 4, 159 (four sections and two subsections but no types selected); Mörch, Yoldi Cat., ii., p. 20, 1853 (*T. literatus* L.).

>*Cuneus* Mörch, Cat. Yoldi, ii., p. 20, 1853.

>*Pullastra* Mörch, Cat. Yoldi, ii., p. 21, 1853 (*V. undulata* Born).

Capsa Leach, Syn. Brit. Moll., p. 209, 1852 (*V. fasciata* Da Costa); not *Capsa* Bruguière, 1797.

Metis H. and A. Adams, Gen. Rec. Moll., ii., p. 436, 1857, not p. 399, 1856 (*Tapes corrugatus* Deshayes).

Myrsus H. and A. Adams, *op. cit.*, p. 660, 1858 (= *Metis* olim).

Tapes Römer, Krit. Unters., p. 16, 1857; H. and A. Adams, Gen. Rec. Moll., ii., p. 434, 1857; Tryon, Syst. Conch., iii., p. 182, 1884; Fisher, Man. Conchyl., p. 1085, 1887.

>*Textrix* Römer, Krit. Unters., p. 16, 1857 (*Venus textile* Gmelin); Mon. *Venus,* ii., p. 18, 1870; not *Textrix* Sundevall, 1833, *Arachnida.*

>*Paratapes* Stoliczka, Cret. Pel. India, p. 144, 1871; Tryon, Man. Conch., iii., p. 182, 1884; = *Textrix* Römer, olim.

>*Parembola* Römer, Krit. Unters., p. 16 (*V. literata* L.); Mon. *Venus,* ii., p. 38, 1870; = *Tapes* Megerle s. s.

>*Amygdala* Römer, Krit. Unters., p. 16, 1857 (*V. decussata* L.); Mon. *Venus,* ii., p. 71, 1870; Tryon, Man. Conch., iii., p. 182, 1884 (not *Amygdala* van Phelsum, 1774, *Echinoidea,* nor *Amygdalum* Megerle, 1811); = *Cuneus* H. and A. Adams, Gen. Rec. Moll., ii., p. 436, 1857, not Da Costa, 1776; and = *Tapes* Gray, 1851.

<*Hemitapes* Römer, Mal. Blätt., xi., p. 83, 1864 (no type selected); Mon. *Venus,* ii., p. 97, 1872; not Stoliczka, Cret. Pel. India, p. 144, 1871, type *Venus pinguis;* or Tryon, Syst. Conch., iii., p. 182, 1884; or Fischer, Man. de Conchyl., p. 1086, 1887 (= *Gomphina* Mörch).

Pullastra Gray, P. Z. S., 1847, p. 184 (*V. pullastra* L.); H. and A. Adams, Gen. Rec. Moll., ii., p. 436, 1857; Stoliczka, Cret. Pel. India, p. 144, 1871; not of Tryon, Syst. Conch., iii., p. 182, 1884 (*P. malabarica* Gmel.).

Saxidomus (*ex parte*) Deshayes, Cat. Conch. Brit. Mus., i., p. 189, 1853.

>*Catelysia* Fischer, Man. de Conchyl., p. 1086, not p. 1084, 1887.

>*Tapes* Bucquoy, Dautzenberg and Dollfus, Moll. de Roussillon, ii., p. 395, 1893 (*T. literatus* L.).

>*Pullastra* Bucquoy, Dautzenberg and Dollfus, Moll. de Roussillon, ii., p. 402, 1893 (*T. pullastra* L.).

>*Amygdala* Bucquoy, Dautzenberg and Dollfus, Moll. de Roussillon, ii., p. 430, 1893 (*Venus decussata* L.).

>*Eutapes* Chiamenti, Revista Ital. Sci. Nat., xx., p. 11, Feb., 1900 (*T. papilionaceus* Lam.).

>*Polititapes* Chiamenti, *op. cit.*, p. 11, Feb., 1900 (*V. aurea* Gmel.).

>*Ruditapes* Chiamenti, *op. cit.*, p. 13, Feb., 1900 (*V. decussata* L.).

>*Callistotapes* Sacco, Moll. Terz. Piem. Lig., xxviii., p. 52 (*Venus vetula* Basterot), April, 1900.

>*Myrsopsis* Sacco, *op. cit.*, p. 57, April, 1900 (*Venerupis pernarum* Bonelli).

>*Taurotapes* Sacco, *op. cit.*, p. 58, April, 1900 (*Venus Craveri* Michelotti).

Leukoma (sp.) Römer, Mal. Blätt., xiv., p. 103, 1867.

Paphia Bolten contained seven species belonging to the genus *Tapes* Megerle, *senso lato,* one *Meretrix* and one *Sunetta,* besides a single unidentifiable species. All these had the same general form and aspect and the genus, for the date when it was proposed, was remarkably compact and homogeneous. The species of *Tapes* were *T. ala-papilionis* Bolten (after Chemnitz) or *papilionaceus* Lamarck, *T. guttulatus* Bolten = *adspersus* (Chemnitz) Sowerby, *T. fasciatus* Da Costa, *T. literatus* Linné, *T. punctatus* Chemnitz (= *literatus* var.), and *T. decussatus* Linné.

Meretrix was separated by Lamarck in 1799, and *Sunetta* by Link in 1807, so the remaining species form the foundation of the revised genus and the name *Tapes,* proposed only in 1811, becomes a synonym unless it be retained in a sectional sense for the species allied to *Venus literata* Linné. In that case the elegant, brightly colored, polished, and concentrically sculptured tropical forms like *P. ala-papilionis* Bolten will represent the typical *Paphia.*

The dentition of *Paphia* has the formula $\frac{\text{L. } 101010.}{\text{R. } 010101.}$, the anterior right and posterior left cardinals always entire, the others often grooved or bifid.

The genus *Paphia* may be divided as follows:

Subgenus *Paphia* Bolten. Type *P. ala-papilionis* Bolten (= *Venus rotundata* pars, Gmelin, non Linné).

Valves elongate oval, subcompressed, with close concentric riblets covered by a vernicose periostracum and without radial sculpture; coloration brilliant, lunule and escutcheon narrow, smooth, impressed, the lunule unequally divided, the right portion encroaching on the left; inner margins smooth, the pallial sinus free, ample, rounded in front, and obliquely ascending. The species are of warm temperate and tropical seas in the eastern hemisphere,

and are reported from the Tertiaries of south Europe since the Eocene. *Eutapes* and *Callistotapes* are synonymous.

Section *Paphia* Bolten s. s. (*vide supra*).

Section *Baroda* Stoliczka, 1871. Type *Venus fragilis* Orbigny. Cretaceous.

Valves elongate, thin, with purely concentric sculpture, the posterior cardinals elongated, sometimes grooved, the others simple; the pallial sinus ample, rounded in front, horizontally directed; margins entire.

This form appears to be the Mesozoic precursor of *Paphia*. The Tertiary *Taurotapes Craveri* (Michelotti) Sacco seems to be hardly differentiable from *Baroda*, judging by Sacco's very obscure figures.

Section *Icanotia* Stoliczka, 1871. Type *Psammobia impar* Zittel, Gosau.

This is stated to differ from *Baroda* only by the presence of more or less radial sculpture.

Section *Paratapes* Stoliczka, 1871. Type *Venus textile* Gmelin.

Valves elongate, turgid, smooth, or with feeble concentric sulci; lunule circumscribed, narrow; escutcheon undefined; middle cardinals bifid, as in *Paphia;* inner margins entire; pallial sinus obliquely ascending, small, squarish anteriorly.

This is *Textrix* Römer, 1857, not Sundeval, 1833.

Section *Protapes* Dall, 1902. Type *Venus gallus* Gmelin (+ *malabarica* Dillwyn).

Valves trigonal, closely concentrically ribbed, with no radial sculpture, a vernicose periostracum, a large, elongate, impressed lunule, no differentiated escutcheon, smooth inner margins, and an ample, obliquely ascending pallial sinus, rounded anteriorly; the two anterior and left posterior cardinals entire, the others bifid; all the teeth short and concentrated.

This is *Pullastra* Chenu, 1862; not of Sowerby, 1826.

Subgenus *Tapes* Megerle, 1811. Type *Venus literata* Linné.

Valves oblong, subcompressed, vertically expanded and subangular on the posterior dorsal margin; lunule circumscribed by an incised line, the escutcheon defined by a carina, both long and narrow; surface concentrically grooved; internal margins smooth; pallial sinus ample, horizontal, free below, rounded in front; the posterior right and two anterior left cardinals bifid or grooved; colors lively, often with a lineated pattern of darker tint on a pale ground.

Tropical and temperate waters of the Old World. *Parembola* Römer is synonymous.

Section *Tapes* Megerle s. s. (*vide supra*).

Section *Polititapes* Chiamenti, 1900. Type *Venus aurea* Gmelin.

Valves oblong, plump, not angular above, behind; the surface with fine concentric sculpture and obscure radial striation; lunule small, circumscribed; escutcheon not defined; pallial sinus short, ascending, free below, rounded in front; color delicate and variable.

This is *Tapes* Sacco, not Megerle. The siphons are united for three-quarters of their length in the British species (*T. virgineus*), which is not known to form a byssus.

Section *Pullastra* Sowerby, 1826. Type *Venus pullastra* Montagu.

Shell oblong, tumid, blunt behind; valves finely reticulately sculptured; the lunule and escutcheon are hardly differentiated, the latter nearly linear; the inner margins are entire; the pallial sinus deep, horizontal, ample, rounded in front and confluent with the pallial line below; the siphons in the type are separated for about one-fourth of their length; the two posterior right and middle left cardinals are bifid; the coloration is feeble.

Section *Myrsus* H. and A. Adams, 1858. Type *Tapes corrugatus* Deshayes.

Valves as in *Pullastra,* but the concentric surface sculpture is broken and corrugated and the shell, having a nestling habit, is very variable in outline; teeth as in *Pullastra;* the lunule obscure or not defined, the margin of the escutcheon feebly carinate; the pallial sinus is small, slightly ascending, free below and rounded in front; the inner margins are smooth; the coloration dull and unattractive.

This is *Metis* Adams, 1857, not 1856; *Myrsopsis* (*pernarum* Bonelli) Sacco, 1900, from the Italian tertiaries, does not appreciably differ.

Subgenus *Ruditapes* Chiamenti, 1900. Type *Venus decussata* Linné.

Valves convex, oblong; surface dull and feebly colored; sculpture strong distally, more or less reticulate, the concentric ridges more or less inosculating anteriorly and feeble on the middle of the shell, the radial sculpture stronger; internal margins smooth; the pallial sinus horizontal, large, free below, rounded in front; the lunule circumscribed, the escutcheon feebly defined; all the inner cardinals more or less bifid; the siphons are wholly free from each

other and the animal is byssiferous. The distribution is in the Old World temperate and tropical regions.

This is *Amygdala* Römer, 1857, not of van Phelsum, 1774; *Cuneus* H. and A. Adams, but not of Da Costa; it is not *Amygdalum* Megerle.

Section *Ruditapes* s. s. (*vide supra*).

Subgenus *Protothaca* Dall, 1902. Type *Venus Dombeyi* Lamarck,= *V. thaca* (Molina) Orbigny, = *Chama thaca* Molina.

Shell ovate, moderately convex; coloration usually whitish or dull; surface not polished, reticulately sculptured, the radials usually stronger; sculpture more or less distinctly divided into three areas, the middle of the valves being chiefly radial, the anterior radial and scabrous, the posterior irregularly concentric; the lunule is sharply circumscribed and the escutcheon of the left valve; the right valve in the type has no corresponding portion of the escutcheon and the margin somewhat overlaps that of the left valve, but does not conceal the ligament; the middle cardinals are usually grooved or bifid; the pallial sinus of moderate size, nearly horizontal, free below and pointed in front; the inner margins are sharply crenulated; the siphons are short, united, and only the incurrent orifice is papillose; the foot is hatchet-shaped and not byssiferous.

The distribution of this group includes the west coast of South America, Japan, and New Zealand (*V. costata* Quoy).

Section *Callithaca* Dall, 1902. Type *Tapes tenerrima* Carpenter. California.

Sculpture uniform over the disk (except in nestling individuals); the lunule feebly defined, the escutcheon not defined; the dorsal margin not overlapping in the right valve, the inner margins entire; otherwise as in the preceding group.

The species of this subgenus are distributed along the shores of the North Pacific in America and Japan. The type dates back to the Miocene in time. It was referred to *Saxidomus* as a sulcate section by Deshayes in 1853. Most of the species are yellowish white with a dull surface, but some of the more southern ones are prettily maculated with brown. There is no byssal groove in the hatchet-shaped foot, and the papillose siphons are united to their tips in the type species. *Callithaca* is Californian.

It may be observed here that most of the European forms of *Paphia* have the siphons more or less united, the minority having them completely free from each other, while the American forms which have been examined have the

siphons almost wholly united and none of them free. The possession of a byssal groove or developed byssus is also characteristic, as far as known, of only a minority of the European forms and is not reported in the American ones. These facts seem, on the basis of the diagnostic characters, to fully justify the suppression of the subfamily *Tapetinæ* of Fischer which I formerly accepted without investigation (see page 552).

The subgenus *Protothaca* is the only one which is represented in North American Tertiary beds, and in these only on the Pacific coast, where *Paphia* (*Protothaca*) *staminea* Conrad occurs abundantly in the Miocene and succeeding horizons, as well as some other species enumerated by Gabb.

Genus **LIOCYMA** Dall.

Liocyma Dall, Proc. Bost. Soc. N. Hist., xiii., p. 256, 1870, *Venus fluctuosa* Gould; Am. Journ. Conch., vii., p. 145, 1871; Fischer, Man. de Conchyl., p. 1086, 1887.

Lyocima Barrois, in Zittel, Traité de Pal., ii., p. 109, 1887.

Tapes (sp.) Deshayes, Cat. Conch. Brit. Mus., i., p. 176, 1853.

Venus (sp.) Gould, Inv. Mass., p. 87, 1841; De Kay, Zool. of N. Y., Moll., p. 220, 1843.

This animal has two moderately developed siphonal tubes with papillose orifices, the anal shorter than the other when both are extended fully. The tubes are united; the foot is long and pointed without a byssus or groove, the mantle open ventrally and smooth-edged. The valves are concentrically waved and covered with a thickish vernicose periostracum; their inner margins are smooth; the pallial sinus is short and rounded triangular, free below from the pallial line. The lunule is circumscribed by a weak incised line, but there is no defined escutcheon. There are three cardinals in each valve; the posterior left and the anterior right are entire, the others bifid or grooved. The teeth and nymphs are smooth with no trace of any lateral teeth. The general form is ovate or rounded trigonal, with moderate convexity. The coloration is white, pale green, or brown, with no pattern markings. The species are all small and confined to the boreal or arctic waters of the northern hemisphere. The genus goes back to the Pliocene in time. Dental formula $\frac{\text{L. 101010.}}{\text{R. 010101.}}$. Although in a general way not unlike *Paphia* in miniature, this little group seems sufficiently distinct to stand as a genus. It is not reported from the Tertiary, but occurs in the Arctic Pleistocene on the Alaskan coast and living in the adjacent seas.

Genus **VENERUPIS** Lamarck.

Venerupis Lamarck, An. s. Vert., v., p. 506, 1818; Blainville, Man. Mal., i., p. 559, 1825 (*V. irus* L.); Payraudeau, Moll. de Corse, p. 35, 1826; Fleming, Brit. An., p. 451, 1828; Philippi, Moll. Sicil., ii., p. 20, 1844.

Venererupes Swainson, Elem. Mod. Conch., 1835, *fide* Agassiz.
Venererupis Sowerby, Conch. Man., p. 113, 1839; Verany, Cat. Gen., p. 13, 1846.
Venerupes Swainson, Malac., p. 376, 1840.
Pullastra (sp.) Sowerby, Gen. Shells, fasc. xxviii., June, 1826.
Rupellaria H. and A. Adams, Gen. Rec. Moll., ii., p. 437, 1857 (not of Fleuriau).
Venerupis Stoliczka, Cret. Pel. India, p. 141, 1871; Fischer, Man. de Conchyl., p. 1087, 1887; Dautzenberg, Moll. de Roussillon, ii., p. 438, 1893.
?Petrifora Latreille, Nat. Fam. Thierr., p. 211, 1827 (no type mentioned).
Irus Herrmannsen, Ind. Gen. Mal., ii., p. 684; not of Oken, Lehrb. der Naturg., pp. 230, 848, 1815.

This genus was, naturally enough, at first confounded, even by Lamarck, with nestlers of other genera. Sowerby proposed to unite the species of *Venerupis* and the group named *Tapes* by Megerle von Mühlfeld in one genus, substituting the name *Pullastra* for that given by Lamarck on the ground that the latter would be inappropriate for the combination. Oken in 1815 proposed a genus *Irus* for three species of bivalves mentioned by Poli, but in his Index he refers one of them to *Pandora* and another to *Petricola,* leaving only one to represent his genus, the *Tellina rhomboides* of Poli, or *Irus rugosus* of Oken, which is a synonym of *Saxicava arctica.* The genus *Irus* Oken is therefore an exact synonym of *Saxicava.*

The genus has long siphons, with papillose orifices, united for about half their length. The foot is grooved and byssiferous. The valves are moderately elongate and subquadrate. The sculpture is radial with prominent rather distant concentric lamellation. There is no lunule, and an area bounded by a keel, in the left valve only, represents what may be called the escutcheon. The ligament is exposed; the pallial sinus short, ascending, free, and blunt in front; the internal margins are smooth in the type. The nepionic shell is polished and colored, the adult dull and rude. The dental formula is $\frac{\text{L. } 101010.}{\text{R. } 010101.}$. The anterior right and posterior left cardinals are entire and slender, the others broad and deeply bifid. The species of the group are nestlers in rock cavities, by reason of which they are frequently deformed and abnormal. They have been much confused with the species of *Petricolidæ,* which have in the adult condition a different dental formula.

Venerupis lamellifera Conrad is reported by Cooper from the Californian Pliocene (under the name of *Rupellaria lamellifera*) and from the Quaternary beds of the coast. A thorough revision of the Californian Tertiary bivalves is likely to reveal other species in their later beds. The genus does not occur on the Atlantic coast of North America.

Subfamily GEMMINÆ.

This group includes small species of Veneridæ which are characterized by viviparity and carry the young, for a considerable period, like *Sphærium*, within the perivisceral chamber. They have, as a rule, purple and white coloration, if any, and a smooth or concentrically striated surface. They live in sand or mud in moderate depths of water on both coasts of North America, and have not been identified from any other region. Other small *Veneridæ* may eventually find a place in this subfamily, but only those of which the status is known are here included in it. A valve of *Gemma* is in the Museum labelled as having been collected in Japan by Stimpson. I do not feel confident of the accuracy of this habitat and await further data before accepting it.

Genus GEMMA Deshayes.

Venus (sp.) Totten, Am. Journ. Sci., xxvi., p. 367, 1834.

Cyrena (sp.) H. C. Lea, Am. Journ. Sci., xlii., p. 106, 1842.

Venus (sp.) Gould, Inv. Mass., p. 88, 1841; Proc. Bost. Soc. N. Hist., p. 61, 1842; De Kay, Zool. N. York, Moll., p. 218, 1843; Mighels, Boston Journ. Nat. Hist., iv., p. 321, 1843; Jay, Cat. Shells, ed. iv., Suppl., p. 466, 1852; Sowerby, Thes. Conch., ii., *Venus*, p. 737, 1853.

Gemma Deshayes, Cat. Conch. Brit. Mus., i., p. 112, 1853; *Venus gemma* Totten; Stimpson, Checkl. N. E. Coast Shells, p. 3, 1860; Prime, Ann. Lyc. Nat. Hist. N. Y., vii., p. 482; H. and A. Adams, Gen. Rec. Moll., ii., p. 419, 1857.

Totteniana Perkins, Proc. Boston Soc. N. Hist., xiii., p. 148, 1869 (err. typ.).

Tottenia Perkins, *loc. cit.* in errata.

Gemma Tryon, Syst. Conch., iii., p. 180, 1884; Binney's Gould's Inv. Mass., p. 137, 1870; Tryon, Am. Mar. Conch., p. 159, 1873; Verrill, Inv. An. Vineyard Sound, p. 683, 1873; Dall, Bull. U. S. Nat. Mus. No. 37, p. 56, 1889; Journ. of Conch., Manchester, x., No. 8, p. 238, 1902.

Shells small, subequilateral, rounded trigonal, with a rather large, faintly circumscribed lunule, external ligament, and no escutcheon; sculpture of concentric waves or striation; inner margins of the valves crenate; pallial sinus small, distinct, acute, free from the pallial line below; siphons separate, the branchial longer and papilliferous; periostracum polished; hinge with three cardinal teeth in each valve, an elongated posterior left and anterior right lateral tooth received into a groove in the edge of the opposite valve; foot linguiform, not byssiferous. Type *Venus gemma* Totten.

The genus is naturally a native of the east American coast from Maine to Texas, but has been introduced with seed oysters at some points on the Pacific coast. It is represented in the Tertiaries of the Atlantic and Gulf States.

Gemma magna n. sp.

PLATE 57, FIGURE 4.

Miocene of North Carolina at the Natural Well and Magnolia, Duplin County; Pliocene of South Carolina at Todd's Ferry, Waccamaw River; of Florida on the Caloosahatchie and Shell Creek; Pleistocene of North Creek, near Osprey, Little Sarasota Bay, Florida.

Shell trigonal, moderately convex, the anterior end slightly shorter, rounded; the posterior end longer, more pointed; beaks high, pointed; lunule lightly flattened, bounded by an incised line often feeble, lanceolate, about half as long as the anterior dorsal slope; escutcheon not defined; surface sculptured with numerous regular, even, concentric sulci, with wider smooth interspaces; hinge normal, well developed, especially the long lateral laminæ, the cardinals entire; basal margin crenulate, pallial sinus small, angular. Length 7, height 6, diameter 4 mm.

G. magna attains a larger size than any of the later representatives of the genus. It resembles *G.* var. *purpurea* of the recent fauna in its sculpture, but relatively is much less inflated.

Gemma magna variety **virginiana** Dall.

Shell smaller, shorter, more delicate. Length 3.8, height 3.6, diameter 1.6 mm.

From the Miocene of Yorktown, Virginia, in the middle portion of the series; Harris.

This form is the earliest *Gemma* now known, and if I felt sure that it was adult I should separate it specifically from *G. magna,* which appears in the uppermost Miocene just before the opening of the Pliocene epoch. It closely resembles the young of the *G. magna,* and perhaps larger specimens may hereafter turn up.

Gemma trigona n. sp.

PLATE 57, FIGURE 8.

Miocene of North Carolina at the Natural Well and Magnolia, Duplin County; of South Carolina one mile east of Darlington; Pliocene of South Carolina at Todd's Ferry, on the Waccamaw River; of Florida on the Caloosahatchie River.

Shell small, rather acutely trigonal, nearly equilateral; beaks high, lunule three-fourths as long as the dorsal slope; surface smooth or with faint incremental lines, or rarely a few concentric sulci visible near the ends of the valve

or indicating resting stages, when they may cross the disk; hinge very heavy and well developed; basal margins faintly crenulate; pallial sinus small, distinct. Length 4.25, height 4.0, diameter 2.6 mm.

This species is nearly as common as *G. magna* but much smaller and much heavier than *G. magna* of the same size, from which it is further distinguished by its smooth surface.

Gemma gemma Totten.

PLATE 24, FIGURES 1, 3.

Venus gemma Totten, Am. Journ. Sci., 1st Ser., xxvi., p. 367, pl. i., fig. 2, 1834; Russell, Essex Journ., i., p. 58, 1839; Gould, Inv. Mass., p. 88, fig. 51, 1841; Proc. Boston Soc. N. Hist., i., p. 61, 1842; Mighels, Boston Journ. N. Hist., iv., p. 321, 1843; Stimpson, Shells of N. Engl., p. 19, 1851; Sowerby, Thes. Conch., ii., p. 737, pl. clviii., fig. 141, 1853.

Gemma gemma Deshayes, Cat. Conch. Brit. Mus., i., p. 113, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 419, pl. cvii., fig. 3, 1857.

?Venus manhattanensis Prime, Jay's Cat., 4th ed., Suppl., p. 466, 1852; Ann. Lyc. Nat. Hist. N. Y., vii., p. 482, 1862.

Gemma Totteni Stimpson, Checkl. East Coast Shells, p. 3, 1860; Prime, *loc. cit.*, p. 483, 1862.

Tottenia gemma Perkins, Proc. Boston Soc. N. Hist., xiii., p. 148, 1869 (see errata); Verrill, Invert. An. Vineyard Sd., p. 682, pl. xxx., fig. 220, 1873.

>*Gemma purpurea* Dall, Bull. U. S. Nat. Mus. No. 37, p. 56, No. 283, 1889.

Gemma purpurea var. *Totteni* Dall, Trans. Wagner Inst., iii., p. 919, pl. xxiv., figs. 1, 3, 1898.

Gemma gemma subsp. *Totteni* Dall, Jour. Conch. (Manchester), x., No. 8, p. 241, 1902.

Pleistocene of Massachusetts Bay at Point Shirley, Stimpson; living from Labrador south to Long Island Sound and New York Bay, Prime.

This form is more ovate than either of the Tertiary species and more ovate and compressed than the variety *purpurea* H. C. Lea, which, were it not for a certain number of intermediate forms, would be regarded as distinct. The external sculpture is somewhat irregular, the spaces between the concentric sulci varying in width, while the sulci themselves are sometimes very fine and close-set. In well-developed specimens of the southern form the sculpture is relatively strong and regular. Both vary in color. Specimens identified by several of the older naturalists with *Venus manhattanensis* seem to me to be merely pale or white specimens of the present form.

Gemma gemma variety **purpurea** Lea.

PLATE 24, FIGURES 2, 4, 4b.

Cyrena purpurea Lea, Am. Journ. Sci., xli., p. 106, pl. i., fig. 1, 1842.
?Venus manhattanensis Prime, in Jay's Cat., 4th ed., Suppl., p. 466, 1852 (name only); Ann. Lyc. Nat. Hist. N. Y., vii., p. 482, 1862.
Parastarte concentrica Dall (name only), Bull. U. S. Nat. Mus. No. 37, p. 48, 1889.
Gemma purpurea Dall, Trans. Wagner Inst., iii., p. 919, pl. xxiv., figs. 2, 4, 4b, 1898.
Gemma gemma subsp. *purpurea* Dall, Journ. Conch. (Manchester), x., No. 8, p. 241, 1902.
Tottenia manhattanensis Verrill, Inv. An. Vineyard Sd., p. 682, 1873.

Pleistocene of the Texas coast at Corpus Christi; living from the south side of Cape Cod south to the Bahamas and west to the coast of Texas.

The type specimens of H. C. Lea are in the National Museum and are certainly young shells of the southern inflated, strongly sculptured form of *Gemma*. The name therefore has twenty years' precedence of *manhattanensis*. The true place of the latter is somewhat doubtful because the figure given by Prime is very inaccurate, and the specimens I have seen labelled *manhattanensis* by Stimpson and others are certainly only pale forms of *G. gemma*. But if we disregard the details of the figure and attend merely to Prime's diagnosis we find *manhattanensis* differentiated from *gemma* by being "smaller, more triangular, less full, less elongated," and white instead of purple. Now adult *purpurea* is larger and more inflated than adult *gemma*, but Prime's specimens were young, only three millimetres long, while the adult reaches 5.25. I find specimens of *purpurea* three millimetres long are sometimes more compressed than the adult *gemma;* they are generally paler and often white. The coarse and regular striæ also point towards *purpurea*. It seems likely that Prime's species was founded on young, whitish specimens of *G. purpurea* and afterwards became confused by collectors with the white mutation of *G. gemma*. In either case the name falls into synonymy.

Genus **PARASTARTE** Conrad.

Parastarte Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 288, 1862, *Astarte triquetra* Conrad; Dall, Proc. U. S. Nat. Mus., vi., p. 339, 1883; Bull. U. S. Nat. Mus. No. 37, p. 48, 1889.
Callicistronia Dall, Science, ii., p. 447, Sept. 28, 1883.
Goodallia Tryon, Syst. Conch., iii., p. 227, 1884; not of Turton, 1822.

Shell small, heavy, trigonal, with elevated and prominent beaks, equilateral, equivalve, with a short ligament and large lunule; surface smooth, with a vernicose periostracum and purple and white coloration; inner margins crenate;

pallial line with a slight flexuosity behind, but no angular sinus; hinge with one strong and two feeble entire right cardinals and in the left valve two strong cardinals; dorsal margins grooved outside of the hinge-plate, as in *Gemma,* but more feebly.

Type *Astarte triquetra* Conrad.

This genus has many of the features of *Astarte* superficially, but evidently belongs to the *Veneridæ* and is nearly related to *Gemma,* like which it is viviparous. It has a long lineage in the Tertiary beds and is, so far as known, exclusively American in distribution.

Parastarte triquetra Conrad.

Astarte triquetra Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 24, pl. i., fig. 6, 1845.

Parastarte triquetra Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 288, 1862; Dall, Proc. U. S. Nat. Mus., vi., p. 339, 1883; Bull. U. S. Nat. Mus. No. 37, p. 48, pl. xlix., figs. 6, 7, 8, 1889.

Callicistronia triquetra Dall, Science, 1st Ser., ii., p. 447, Sept. 28, 1883 (olim).

Micene of Jackson Bluff, Ocklockonnee River, Florida, Vaughan; Pliocene of south Florida in the marls of the Caloosahatchie, Shell Creek, Alligator Creek, and the Myakka River; Pleistocene of North Creek, near Osprey, Florida, Dall; living from Hillsboro' Inlet, East Florida, south to the Keys and northward to Cedar Keys on the west side of the peninsula.

This seems to be a characteristically Floridian type, being, so far as yet known, confined to the peninsula, whether recent or fossil.

Tryon seems to have supposed that the small shells included by Deshayes under the name of *Goodallia* from the Parisian Eocene, and afterwards named by Cossmann *Microstagon,* are generically identical with *Parastarte,* but this is an error. The type of *Goodallia* is an *Astarte* somewhat modified, and does not belong in the *Veneridæ.* It will be more fully discussed under *Astartidæ.*

Genus **PSEPHIDIA** Dall, 1902.

Psephidia Dall, Journ. Conch. (Manchester), x., No. 8, p. 243, 1902.

Psephis Carpenter, Suppl. Rep. Brit. Assoc. for 1863, p. 640, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 56, 1865. Type *P. Lordi* Cpr.; not *Psephis* Guenée, 1854, Lepid.

Psephis Tryon, Syst. Conch., iii., p. 177, 1884; Fischer, Man. de Conchyl., p. 1084, 1887.

Venus (sp.) Gould, Journ. Boston Soc. N. Hist., vi., p. 406, 1853.

Trigona (sp.) Carpenter, P. Z. S., 1856, p. 201.

Shell small, veneriform, polished, with only concentric sculpture if any; beaks not prominent, valves inequilateral, with a narrow, feebly defined lunule

and no escutcheon; surface feebly concentrically striate or smooth, with a polished periostracum; inner margins not crenate; pallial sinus angular, well defined; hinge with three delicate cardinal teeth in each valve, with no lateral teeth; dorsal margins outside the hinge-plate, faintly grooved.

Type *Psephis Lordi* Carpenter, Vancouver.

The animal has the mantle edges fused below and the siphons are represented by orifices with slightly produced margins without papillæ. Anteriorly the mantle is open for the passage of the foot, which is not byssiferous. It is viviparous. The genus is west American, so far as known, and is represented in the Pacific Pliocene.

Venus rhysomia Gabb was identified by Carpenter with a shell which he called *Psephis* (*V. tantilla* Gould), but this is not a *Psephidia,* and, though not typical, should probably be referred to *Transennella.* It occurs fossil in the Pleistocene of Santa Barbara, California.

Family CYRENELLIDÆ.

This is the *Cyrenellidæ* of Gray in 1857 and the *Cyrenoididæ* of H. and A. Adams of slightly later date. It contains, as far as known, only one genus, *Cyrenoida,* common to the brackish waters of the shores of the middle Atlantic. The soft anatomy recalls the *Diplodontidæ;* the hinge-structure is, however, distinct from that of any other Lucinoid. It has an archaic appearance and is composed of, in the right valve, two, and, in the left valve, one intercalary long anterior 7-shaped teeth, each representing a potential lateral and cardinal which never reach the point of differentiation. There are no indications of any posterior teeth at all. The account of the teeth given in Fischer's Manual seems to have been based upon one of the fluvial *Diplodontidæ* elsewhere recorded under the name of *Joannisiella,* which were long confounded with *Cyrenoida,* but which have a perfectly distinct type of dentition. At any rate, for the typical *Cyrenoida* his description is inaccurate both as regards the number and form of the teeth.

The animal has a foot resembling *Loripes,* gills and palpi like those of *Diplodonta,* and united rather elongate siphons, but, curiously enough, no sinus in the pallial line.

Genus **CYRENOIDA** Joannis.

Cyrenoida Joannis, in Guérin, Mag. de Zool., 1835 (June), pl. lxiv. and text. Sole example *C. Dupontia* Joannis, *loc. cit.,* Senegal.

Cyrenella Deshayes, in Guérin, Mag. de Zool., 1836 (Feb.), pl. lxx. and text; Chenu, Man. de Conch., ii., p. 105, 1862; Fischer, Man., p. 1096, 1887.

Cyrenoides Sowerby, Conch. Man., 2d ed., p. 135, fig. 114, 1842; Woodward, Man. Rec. and Fos. Sh., p. 298, pl. xix., fig. 19, 1855; Tryon, Struct. and Syst. Conch., iii., p. 187, 1884.

Cyrenoidea Hanley, Ill. Cat. Rec. Biv. Shells, Expl. Suppl. pl., p. 10, 1846; Dall, Nautilus, x., p. 51, 1896.

Cyrenodonta H. and A. Adams, Gen. Rec. Moll., ii., p. 453, 1857; not of Joannis, Mag. de Zool., expl. pl. lxx., Feb., 1836 (nomen nudum).

Cyrenoida Hanley, Ill. Cat. Rec. Biv. Shells, App., p. 352, 1846; Philippi, Handb. der Conch., p. 316, 1853; Gray, Fig. Moll. An., v., p. 18, pl. cccxlvii., figs. 1–3, 1857; H. and A. Adams, Gen. Rec. Moll., ii., p. 452, pl. cxi., figs. 5, 5a, 5b, 1857.

The name of this genus as applied in the first paper of Joannis has been regarded by many authors as malformed or due to a typographical error, but Philippi claims it to be correctly compounded of two Greek words, and, as it has been accepted by several eminent writers, it will be best to retain it as originally written, though the insertion of the penultimate *e* would make it more euphonious. It has nearly nine months' precedence in print of *Cyrenella* Deshayes. The name of the type, dedicated to Madame Dupont, should be *Dupontæ* or *Dupontiæ*, and not *Dupontii* or *Dupontia*, as spelled by Joannis and others.

Cyrenoida caloosaënsis Dall.

Plate 51, Figure 5.

Cyrenoidea caloosaënsis Dall, The Nautilus, x., p. 52, Sept., 1896.

Pliocene marls of the Caloosahatchie River, south Florida; Dall and Willcox.

This is the largest species of the genus and has the best developed hinge of any.

The other two American species are only known in a recent state, *C. floridana* Dall, on the Georgia and Florida coast, and *C. americana* Morelet, 1851, described from Porto Rico. The typical species occurs in the estuaries of west African rivers, and was received first from Senegal and later from Liberia. All are very similar, and discriminated only by minor differences in the hinge and general form and color.

Family THYASIRIDÆ.

Genus **THYASIRA** (Leach) Lamarck.

Thyasira (Leach MS.) Lamarck, An. s. Vert., v., p. 492 (in synonymy), 1818; *Tellina flexuosa* Montagu, sole example. Leach, Moll. Gt. Brit., p. 311, 1852; Stimpson, Shells of N. Engl.

Thyassira Blainville, Dict. Sci. Nat., liv., p. 333, 1829 (err. typ.).

Thyatira Jeffreys, Mal. Conch. Mag. No. 2, p. 42, 1839; Gray, Ann. Mag. Nat. Hist., xx., p. 272, 1847; Gray, List Brit. An., Moll., p. 99, 1851; not of Hubner, 1816 (Lepid.).

Thiatyra Sowerby, Conch. Man., 2d ed., p. 274, 1842.

Bequania (Leach MS.) Brown, Ill. Conch. Gt. Brit., 1st ed., pl. xvii., figs. 4, 5, 1827; 2d ed., p. 99, pl. xxxix., figs. 4, 5, 1844 (*Tellina flexuosa* Mtg.).

Axinus J. Sowerby, Min. Conch., iv., p. 11, 1821 (not *Axina* Kirby, 1817). Type *A. angulatus* Sby., *op. cit.*, p. 11, pl. cccxv.; Jeffr., Brit. Conch., ii., p. 245, 1863.

Cryptodon Turton, Dithyr. Brit., p. 121, 1822; *Tellina flexuosa* Mtg.

Clausina Jeffreys, Ann. Mag. N. Hist., xx., p. 18, 1847 (*Axinus ferruginosus* Forbes); not *Clausina* Brown, 1827 (*Chione*).

Ptychina Philippi, Moll. Sicil., i., p. 15, 1836; ii., p. 11, 1844, sole ex. *P. biplicata* Phil., *op. cit.*, i., pl. ii., fig. 4.

Megaxinus Brugnone, Bull. Soc. Mal. Italiana, vi., p. 146, 1881. Type *Lucina rostrata* Pecchioli.

Axinus Fischer, Man. Conch., p. 1098, 1887; Cossmann, Cat. Ill. bas. Paris, ii., p. 29, 1887.

Cryptodon Smith, Challenger Lam., p. 187, 1885; Dall, Bull. U. S. Nat. Mus. No. 37, p. 50, 1889; not of Conrad (*Mactridæ*), 1837; nor *Cryptodonta* (Nuttall MS.) Carpenter, Rep. Brit. Assoc., 1863, p. 525.

>*Philis* Fischer, Journ. de Conchyl., ix., p. 345, 1861; sole ex. *P. Cumingi* Fischer, *op. cit.*, pl. xvi., figs. 8, 9.

Conchocele Gabb, Pal. Cal., ii., p. 27, 1866. Type *C. disjuncta* Gabb, *op. cit.*, p. 28, pl. vii., figs. 48, a–b.

Schizothærus Locard, Ann. de l'Univ. de Lyon, p. 180, 1896; not of Conrad, 1853.

>*Axinulus* Verrill and Bush, Proc. U. S. Nat. Mus., xx., p. 790, 1898. Type *Cryptodon* (*Axinulus*) *brevis* V. and B., *op. cit.*, pl. lxxxix., figs. 7–8.

>*Axinodon* Verrill and Bush, *op. cit.*, p. 795. Type *A. ellipticus* V. and B., pl. xc., figs. 5, 6, pl. xcii., fig. 1, 1898.

This genus has given rise to much discussion and many synonyms. The earliest name is that of Leach as quoted by Lamarck, and which, in my opinion, is not interfered with by the differently spelled name of Hübner. In the larger species there is often a minute denticle under the beak, but Gabb mistook the flat lamina upon which the resilium rests, in his *Conchocele*, for a tooth. The remarkable anatomical characters of these animals separate them from the *Lucinidæ*. It remains to be seen how many genera can be properly grouped with them from among the *Lucinoid* forms, of which so little is known. The ligament and resilium are juxtaposed, elongated, and subequal, the former visible externally, the latter immediately below it, between the edges of the valves. From the shells only one subdivision may be sectionally set off, namely, *Philis* Fischer, which bears to the ordinary *Thyasira* such a relation as *Bothro-*

corbula does to *Cuneocorbula,* or *Here* to *Lucina.* In *Philis* the lunular region is deeply impressed to make a subspherical fossette, as in the other groups referred to. It is noticeable that in all the cases where this peculiar feature occurs the pyxidiferous form is tropical, while the related forms, without the fossette, are from cooler water.

The largest known species is the *Thyasira bisecta* of Conrad from the Miocene of the Pacific coast, which has survived in the deeper water of Puget Sound until the present day. It has occurred to me that possibly the anomalous genus *Ludovicia* (Desh. MS.) Cossmann may be related to *Thyasira* (cf. Cossm., Ill. Cat., ii., p. 49, pl. ii., figs. 21–22, 1887). Some of the elongated species, if the posterior fold were smoothed out (and it is sometimes nearly obsolete), would much resemble *Ludovicia squamula.*

The most prominent features of the larger species of *Thyasira* comprise the posterior plications of the shell, the indentation of the hinge-margin just in front of the beaks, which forms a pseudo-tooth, as long since observed by Philippi and others, the edentulous hinge-margin, lucinoid adductor scars, and thin, colorless valves with entire margins. The plications in the very young and in the smaller species are frequently obsolete or absent, but every stage between those with and those without them is observable in a large collection of species. While we may separate the smooth forms for convenience sectionally, there will be some which will only be assigned a place with difficulty, being so strictly intermediate. The species follow in many respects the mutations of the Lucinas. Both have a minute, deeply impressed lunule in many forms, which is more patulous in the right valve than in the other, and often grades into a dentiform process fitting into a socket in the valve opposite. In the various species of *Axinopsis* this formation may be traced through mutations which culminate in a well-developed tooth in the most specialized species. In both *Lucina* (senso lato) and *Thyasira* the anterior and posterior dorsal areas (or plications) grade from most pronounced formations to obsolescence. In both the ligulate anterior adductor scar varies from long to short. In both the ligament and resilium are generally united and inset in a groove, though in *Thyasira* the hinge-margin is so thin that there is no opportunity for the resilium to separate from the ligament and become embedded by itself in the mass of the hinge-plate, as occurs in *Loripes.* The only change I have observed corresponding to this is a relative thickening of the resilium, which becomes spread out on the under side of the hinge-margin without, however, becoming truly internal, *i.e.,* invisible from outside when the valves are closed.

In *Thyasira* proper I have seen no instance in which a true tooth is de-

veloped on the hinge apart from the lunular nodosity, though as in other edentulous bivalves it frequently happens that minute irregular nodulations may occur at the inner (proximal) end of the ligament below the beaks.

Some of the forms of *Axinopsis,* as already stated, arrive at a point where they may be said to have true cardinal teeth, though these appear to originate by the infolding of the anterior sublunular hinge-margin and not by the development from primordial lamellæ, as in most Pelecypods. In *Leptaxinus* we have also well-developed laterals, and in one of the species, *L. incrassatus,* Jeffreys has figured what appears to be a provinculum.

The extraordinary arborescent hepatic and genital glands appear to be characteristic of this family, and have been shown by Friele (1877) to exist in *Axinopsis,* a fact which I have confirmed.

I have noticed in the young a much greater variation in outline than occurs in the adult, and it therefore becomes necessary in dealing with very minute forms to assure oneself that one is dealing with mature animals before assigning too high a systematic value to such mutations.

The family may conveniently be divided into the following genera and minor groups:

Genus *Thyasira* (Leach). Type *T. flexuosa* Montagu.

Section *Thyasira* s. s.

Valves with edentulous hinge, the anterior dorsal area more or less impressed, the posterior more or less distinctly plicate or radially sulcate.

Philis (Fischer), 1861, has a deeply impressed lunule, but this character intergrades with the other species.

Megaxinus Brugnone, 1881, differs only in having the ligament strong and deeply inset (not occluded), much as in *Codakia,* and supported by a more prominent nymph than in the ordinary *Thyasira.*

Section *Axinulus* Verrill and Bush, 1898. Type *T.* (*A.*) *brevis* V. and B., Proc. U. S Nat. Mus., xx., p. 790, pl. lxxxix., figs. 7, 8, 1898.

Shell minute, ovate or oblong, with the dorsal areas obsolete.

Axinodon Verrill and Bush, 1898, appears to be synonymous.

Genus *Axinopsis* G. O. Sars, 1878. Type *A. orbiculatus* Sars, Moll. Reg. Arct. Norv., p. 63, pl. xix., figs. 11 a–d, 1878.

Valves with one or more cardinal teeth, shell small, solid, with no posterior dorsal area or plication.

Genus *Leptaxinus* Verrill and Bush, 1898. Type *L. minutus* V. and B., Proc. U. S. Nat. Mus., xx., p. 797, pl. lxxxix., figs. 3–5, 1898.

Shell like *Axinulus* but with distinct lateral teeth.

?Genus *Ludovicia* Cossmann, 1887. Type *L. squamula* Cossmann, Cat. Illustr., ii., p. 49, pl. ii., figs. 21, 22, 1887. Eocene of the Paris basin.

Valves rounded-triangular, subcompressed, edentulous, with minute prominent umbones.

The type of the genus *Thyasira* has a somewhat complicated synonymy:

Thyasira flexuosa Montagu.

Venus sinuosa Donovan, Nat. Hist. Brit. Sh., pl. xlii., fig. 2, 1801; not of Pennant, Brit. Zool., iv., p. 95, pl. xciv., fig. 51, 1777.

Tellina flexuosa Montagu, Test. Brit., p. 72, 1803.

Amphidesma flexuosa Lamarck, An. s. Vert., v., p. 492, 1818.

Thyasira flexuosa Lamarck, as of Leach, *loc. cit.*, in synonymy.

Lucina sinuata Lamarck, *op. cit.*, v., p. 543, 1818; Hanley, Cat. Rec. Sh., p. 77, 1844.

Ptychina biplicata Philippi, En. Moll. Sicil., i., p. 15, 1836; ii., p. 4, 1844.

Lucina sinuosa Thorpe, Brit. Mar. Conch., p. 74, 1844; not of Roemer, Paleontographica, iii., p. 32.

Cryptodon bisinuatus S. Wood, Ann. Mag. N. Hist., vi., p. 247, Nov., 1840; Crag Moll., ii., p. 134, pl. xii., f. 20 a–b, 1853.

Axinus sinuatus Philippi, Zeitschr. Malak., 1845, p. 91.

?Axinus Sarsii Philippi, *loc. cit.*, 1845; Lovèn, Ind. Moll. Scand., p. 38, 1846.

?>Axinus flexuosus var. *rotunda* Jeffrys, P. Z. S., 1881, p. 701.

Fossil in European Neocene and Pleistocene, also recent in northern Europe, the North Atlantic south to the Canaries and Azores, the Mediterranean; ?Greenland, not Labrador and northeastern North America; two to five hundred fathoms.

Donovan's figure appears to me to be taken from a distorted specimen of this species, of which there are several in the Jeffreys collection, but his name was preoccupied for another species by Pennant, which Montagu recognized in renaming it *flexuosa*. Jeffreys unites several forms which appear to me distinct under the head of this species, and has been followed by Posselt (Consp. Fauna Grönl., p. 80, 1898). Among these are the *T. Sarsii* Philippi, which is known from north Europe and Greenland but not from America, east or west. The shell regarded as a variety *rotunda* by Jeffreys is a deep-sea form near to *T. equalis* Verrill and Bush, but less truncate behind, the *T. Gouldii* Philippi

of northeast and northwest America, and the so-called variety *polygona* (*T. trisinuata* Orbigny) Jeffreys, which is distributed very widely. It must be confessed, however, that the mutations of the species are considerable enough to afford some excuse for the view of them taken by Jeffreys.

Thyasira Gouldii Philippi.

Lucina flexuosa Gould, Inv. Mass., p. 72, fig. 52, 1841; not of Montagu, 1803.
Axinus Gouldii Philippi, Zeitschr. Malak., 1845, p. 75.
Tyatira hyalina Beck (MS.?), 1847, *fide* Mörch, in Rink's Greenland, 1857, p. 19.
Thyasira Gouldii Stimpson, Sh. of N. Eng., p. 17, 1851; Mörch, in Rink's Greenland, p. 19, 1857; Arctic Man., p. 131, 1875; Dall, Synopsis Lucinacea, p. 786, 1901.
Cryptodon Gouldii Verrill, Inv. An. Vineyard Sound, p. 686, pl. xxix., fig. 213, 1873; Dall, Bull. U. S. Nat. Mus., No. 37, p. 50, pl. lviii., fig. 2, 1889.
Axinus flexuosus Montagu var. *fide* Jeffreys.

Pliocene of Dead Man's Island, San Pedro, California; Pleistocene of northeastern North America and Bering Sea; recent from Hekla Harbor, Greenland, south to Stonington, Connecticut, in five to four hundred fathoms; Bering Sea and southward to Korea on the west, and Queen Charlotte Islands on the east, of the North Pacific.

Thyasira bisecta Conrad.

Venus biscta Conrad, Geol. Wilkes Expl. Exp., p. 724, pl. xvii., fig. 10, 1849.
Cyprina bisecta Conrad, Am. Journ. Conch., i., p. 153, 1865; Eocene Checklist, S. I., p. 6, No. 160, 1866.
Thyatira? bisecta Meek, Miocene Checklist, S. I., p. 8, No. 247, 1864.
Conchocele disjuncta Gabb, Pal. Cal., ii., p. 28, pl. vii., fig. 48a–b, 1866; p. 99, 1869.
Conchocele bisecta Gabb, Pal. Cal., ii., p. 99, 1869.
Thyasira bisecta Dall, Synopsis of Lucinacea, p. 817, pls. xl., xlii., figs. 5, 8, 1901.

Miocene of Astoria, Oregon, Dana; Pliocene of San Pedro, California, Dall; living in Puget Sound, O. B. Johnson and United States Fish Commission.

This remarkable species is found in the Pliocene (not the Post-Pliocene, as stated by Gabb) of Dead Man's Island off San Pedro, but is entirely absent from the Pleistocene of San Pedro Hill on the mainland. The edges of the rather delicate nymphs upon which the ligament was seated were mistaken by Gabb for lateral teeth. I have been unable to detect any differences of systematic value between the Miocene fossils and the recent shells dredged by the Fish Commission.

Thyasira trisinuata Orbigny.

Lucina trisinuata Orbigny, in Sagra, Moll. Cubana, ii., p. 300, pl. xxvii., figs. 46–49, 1846.

?Lucina flexuosa Fischer, in Beau, Cat. des Coq. rec. à la Guadeloupe, p. 23, 1857.

Axinus flexuosus var. *polygona* Jeffreys, Brit. Conch., ii., p. 248, 1863.

Cryptodon obesus Verrill, Am. Journ. Sci., iii., p. 287, pl. vii., fig. 2, 1872 (non G. O. Sars, 1878); Trans. Conn. Acad., iii., p. 11, pl. i., fig. 11, 1874; Rep. Inv. An. Vineyard Sd., pp. 509, 687, pl. xxix., fig. 214, 1874; Proc. U. S. Nat. Mus., iii., p. 399, 1880; Trans. Conn. Acad., v., p. 569, 1882; Dall, Bull. U. S. Nat. Mus. No. 37, p. 50, pl. lviii., fig. 12, 1889.

Thyasira trisinuata Dall, Synopsis of Lucinacea, p. 786, 1901.

Rare in the Pliocene marls of the Caloosahatchie and Shell Creek, Florida, Dall, Willcox, and Burns; living from Labrador to Martinique in the western Atlantic in fifteen to two hundred fathoms, and on the northwest coast of America at Sitka, Alaska, in ten fathoms, and on the coast of Korea, St. John.

This widely distributed form is rare in the Pliocene marls and attains a larger size as we follow it northward or into the colder water of the deeps.

A minute shell about one millimetre in diameter, ovate, smooth, edentulous, and moderately convex, was found in the Claiborne sand. If certain that it is adult, I should be disposed to refer it to the section *Axinulus,* but I have a suspicion that it is merely the nepionic young of a species of *Lucina,* and so prefer to await further information before giving it a name.

Family LUCINIDÆ.

The first elimination of forms belonging to this family from the heterogeneous groups of the pioneer authors was by Scopoli (1777), who Latinized Adanson's native name in the form of *Codakia,* with Adanson's species as the type. The species is somewhat doubtful, since Deshayes (An. s. Vert., ed. ii., vi., p. 318) identifies it with Lamarck's *Cytherea interrupta* (which Reeve denies), and other authors with *Venus orbicularis* or *V. tigerina* of Linnæus (1758). It appears to be certain, however, that it is generically identical with both of the last two mentioned, and if specifically the same as either of them, probably with the former of the two.

Bruguière in 1792 had not discriminated either of the Lucinoid genera, but in the volume of plates to the Encyclopédie Méthodique which appeared in 1797 there are two plates of species belonging to this group with the legend "Lucina." The genus was adopted by Lamarck in 1799, who describes it and cites a single example, the *Venus edentula* of Linnæus. This must therefore be considered as the type, as already recognized by Fischer in his "Manual."

The Linnean species, among several closely similar forms now known, cannot be positively identified, but, according to Hanley, is probably the *L. ovum* Reeve, a Red Sea species. The genus, however, is unmistakable, and was subsequently named *Anodontia* by Link (1807).

In 1791 Poli recognized the chief anatomical peculiarities of a Mediterranean species, and *Loripes,* one of several names he applied to it, was introduced into binomial nomenclature by Oken in 1815, and adopted by Cuvier two years later for the *Tellina lactea* (Poli) Gmelin (non Linnæus), which has many synonyms.

In 1817 Schumacher named several Lucinoid forms, though several of the names were already in use, and that which he adopted as typical *Lucina* is not the original *Lucina* of Lamarck.

In 1822 Turton proposed *Myrtæa* for the *Venus spinifera* of Montagu, and in 1825 Blainville gave the name of *Phacoides* to a group typified by *Lucina jamaicensis* of Lamarck, the *Tellina pectinata* of Gmelin. Subsequent divisions will be treated under their particular heads, the above synopsis accounting for the nomenclature of the chief groups in their historical sequence.

The dental formula for the *Lucinidæ,* in its fullest development, appears to be single right and double left laterals on each side of the beaks, while the cardinals are $\frac{\text{L. } 10\frac{1}{2}0}{\text{R. } 0\frac{1}{2}01}$. The inner pair, if any, are those which are grooved or bifurcate, though they are often entire, while the outer pair show no bifurcation. The anterior right cardinal is frequently absent or represented only by a rudiment, and a single right cardinal is characteristic of the genus *Myrtæa.* In other groups, unless well developed, the dwarfed cardinal may be indifferently present or absent in different stages of the same individual or different individuals of the same species. It is almost invariably absent when the lunular impression is exceptionally deep, as often occurs, leaving no space for the anterior tooth to develop.

The teeth are very subject to reduction by obsolescence, sometimes the laterals, sometimes the cardinals, and sometimes both, becoming gradually obsolete in the adult shell. It often happens that the young shells of the same species will show a relatively well-developed dentition when the adult has hardly a trace of the teeth. The cardinals in species which have a deeply impressed lunule seem to be affected injuriously by the invagination of the margin adjacent to them. The laterals as a rule, as in other groups, are less constant in their development than the cardinals. The duplication of the lateral laminæ to hold the single lamina of the opposite valve is, in all the cases I have studied, developed in the left valve, though Bernard ascribes it to the right valve, per-

haps by a *lapsus pennæ*. But in most cases there is no duplication, and in many species the laterals have entirely vanished.

The ligament and resilium are usually, though not always, united in this family, generally somewhat inset, but rarely truly internal. In *Codakia* may be noted (in fresh and still united specimens) a unique feature in that a solid shelly coating is deposited on the external surface of the ligament. It is usually scaled off in dry specimens if an attempt to separate the valves has been made.

The valves of the more characteristic *Lucinidæ* have usually two more or less compressed areas dorsally, marked off by this compression, by a radial sulcus, or by a change in sculpture from that in the middle part of the disk. These I have termed the anterior and posterior dorsal areas; they are sometimes spoken of as anal and oral areas. They are sometimes obsolete or, especially the anterior one, marked off only by an impressed line. This may be mistaken for a lunular boundary; but the lunule, which in this group is usually small and often asymmetrically developed as regards the two valves, is usually demarcated by a ridge or angle, and not, as in *Veneridæ*, by an incised line. The lunular characters are very constant and useful in this group for specific discrimination, such variation as there is in them being chiefly in the matter of depth below the general level of the valve. In general the concentric sculpture dominates the radial; I have seen no species in which radial sculpture is present to the exclusion of the concentric. One might suppose that external sculpture, being one of the characters most subject to be impressed by environmental conditions, would be inconstant compared with some of the less exposed features. This, however, is not the case; the types of sculpture are remarkably persistent, existing without essential change from the earliest Tertiary in many lines of Lucinoid development. The explanation probably is that the varieties of conditions which affect sculpture are limited in number and very constant from one geological era to another, and certain types, having developed a sculpture which is qualified to harmonize with these conditions, hand it on to their descendants practically without change from age to age. The margins of the valves are usually entire or feebly crenulate, in conformity with the absence of strong radial sculpture. The pallial line is always entire, but often rather rude or ragged. The anterior adductor scars afford one of the most characteristic Lucinoid characters in their tendency to a prolongation within the disk bounded by the pallial line. They sometimes reach nearly halfway across the disk and extend below the centre of mass of the body. The posterior scar is more rounded and higher up in the valve, but it should be noted that the amount of prolongation of the anterior scar appears to vary very considerably in allied

species. The presence of these strong and extensive muscles, combining with a well-developed ligament or resilium to steady the valves in their mutual positions, doubtless makes up for the absence of a strong dental armature or marginal serration in preventing injurious rotation of one valve on the other. The mantle in this family is more closely adherent to the disk over its whole surface than in most bivalves, and in many species is permanently attached by small areas producing a system of punctuations of the shell over the disk. Sometimes, indeed, larger irregular areas become attached and leave a permanent impression on the shell. But these are individual mutations of no systematic import. A ramification of the genital organ, when swollen with ova, often leaves an oblique sulcus across part of the disk which is very generally present in the more heavy-shelled *Lucinidæ*. The peculiarities of the gills in this group have already been alluded to (pp. 505, 544), and the very general feature of an elongated, club-shaped, or cord-like foot. The latter, however, is a character which varies in different members of the family as it does in the *Diplodontidæ*. Thus in *Jagonia* the foot is nearly normal and but moderately elongated in *Codakia*, while in *Phacoides* and *Lucina* it is much elongated. There are no siphons properly so called in the *Lucinidæ*. Their place is taken by simple orifices in the posterior margin of the mantle. The little organ usually alluded to as the " valve" of the anal siphon, and which is distinguished from the siphon by being introvertible, occurs in many groups of Pelecypods. In *Lucinidæ*, however, it is developed to an extraordinary extent and takes the place of a siphon for the exhalent orifice. Being usually introverted and greatly contracted in alcoholic specimens, it is often overlooked, but occurs in all groups of the family I have been able to examine.

Genus **CODAKIA** Scopoli.

Codakia Scopoli, Intr. ad Hist. Nat., p. 398, 1777. Type *Chama codok* Adanson, Senegal.

Lentillaria Schumacher, Essai, p. 147, 1817. Type *Venus punctata* L. (Chemnitz, Conch. Cab., vii., p. 15, pl. xxxvii., fig. 397, 1784).

Orbiculus (sp.) Megerle v. Mühlfeld, Mag. Ges. Naturf. Freunde zu Berlin, p. 58, 1811 (not *Orbicula* Lam., 1799).

Lenticularia Gray, P. Z. S., 1847, p. 196; error for *Lentillaria* Schum.

> *Jagonia* Récluz, Mélanges Malac., p. 14, 1869; Actes Soc. Lin. de Bordeaux, xxvii., p. 39, 1870. Type *Le jagon* Adanson = *Venus orbiculata* Montagu.

> *Ctena* Mörch, Mal. Blatt., vii., p. 201, 1860; *Codakia pectinata* Carpenter.

Antilla de Gregorio, Bull. Soc. Malac. Ital. (Pisa), x., p. 217, 1885. Type *Venus tigrina* L.; not *Antillia* Duncan (corals), 1864.

Codokia Fischer, Man. de Conch., p. 1143, 1887 = *Codakia* em.

Lintellaria Bucquoy, Dollfus and Dautzenberg, Moll. Roussillon, ii., p. 635, 1898 (err. typ. for *Lentillaria* Schum.).

Codakia Dall, Synopsis Lucinacea, p. 797, 1901.

This is a well-marked group which may be divided into two subdivisions with the following characters:

Codakia s. s. Shells large, heavy, with more or less distinctly reticulate sculpture; relatively compressed, with small beaks and lunule; the ligament and resilium large, deeply inset, the former with a calcareous external coating; margins entire; foot moderately elongated. Type *Chama codok* Adanson. Dental formula $\frac{\text{L. lol.1010.lol}}{\text{R. olo.0101.olo}}$, taken from *C. orbicularis* L.

The posterior lateral teeth are obscured by the growth of the ligament in the adult, but traces of them can almost always be noted. The cardinals are not bifid and the right anterior cardinal is often obscured by the excavation of the lunule in front of it.

Jagonia Récluz. Shells small, light, frequently tumid, and very inequilateral; beaks more prominent and lunule relatively often larger; ligament and resilium external, on a narrow nymph, not coated with shelly matter; posterior laterals distinct; margins usually crenulate; foot differing little from the ordinary Pelecypod type. Type *Le jagon* Adanson, = *Venus orbiculata* Montagu + *Lucina pecten* Lam. In these forms the radial part of the sculpture is usually more pronounced than in *Codakia.*

The species of this genus from their general similarity were more or less confounded together by authors until recently. Linné in his original references in the tenth edition of the "Systema Naturæ" correctly differentiated three of the principal forms, two of which he afterwards confounded together. For this reason the specific names have been very generally erroneously applied, notwithstanding these facts were pointed out by Hanley half a century ago. To sum up briefly, the Indo-Pacific region, the West Indian region, and the Panamic province have distinct species of large *Codakia,* of which the East Indian form is the typical *C. tigerina,* the West Indian the *C. orbicularis,* both of Linné, while the *C. distinguenda* Tryon, from the Gulf fauna, has been confounded with the former and with the very distinct, strictly Indo-Pacific *C. punctata* of Linné. These blunders appear to have been aggravated by careless collectors, who labelled specimens of unknown provenance with locality marks belonging to the supposed name and not to the specimen. To this day it is uncertain whether the type of the genus described from Senegal by Adanson is identical with the East Indian form (found at the Cape of Good Hope) or the West Indian shell, though the probabilities are in favor of the latter.

According to Zittel both subdivisions of *Codakia* in European horizons recede to Miocene time, but in the New World they certainly appear as early as the Middle Oligocene. One species, which Mr. T. H. Aldrich identifies with Conrad's unfigured *Lucina perlevis* of the Vicksburgian (and, if so, most unhappily named), occurs at Red Bluff and Carson's Creek, Mississippi, as well as at Vicksburg, and, while not a characteristic *Jagonia,* would undoubtedly be best placed in that group, having well-developed radial as well as concentric sculpture. It must be borne in mind in considering my references of Eocene forms that few of them have attained the full development of the groups to which I have referred them when the latter are best developed in or typified by species of later horizons. They do, however, constitute what Agassiz used to call synthetic types, and often seem, as one might expect, nearly intermediate between groups which in the Miocene or Pliocene have become well differentiated. In such cases I have used my best judgment as to the preponderance of characters, while recognizing that a different opinion might easily find some facts to support it.

In the white Oligocene limestone of Clairmont, St. Ann's, Jamaica, which is regarded by Hill as somewhat older than the Bowden horizon, a well-developed species of *Codakia* occurs, of which fragments insufficient for description are in the National Museum. So far as sculpture and general form are concerned it can hardly be discriminated from the recent *C. orbicularis.* It may very likely be this species which Guppy has listed under the name of *Lucina tigrina* from the " Miocene" of Jamaica. I have not seen any species in the Bowden marl which closely simulated *C. orbicularis,* though analogues of several recent forms (which have been referred to under names given to recent species) occur, as will be shown later.

Codakia spinulosa n. sp.

PLATE 52, FIGURE 19.

Oligocene of the Bowden marl, Jamaica, West Indies.

Shell nearly orbicular, moderately and regularly convex, solid, with pointed, low, prosogyrate beaks; lunule small, deep, cordiform; sculpture of small, low, flattish, indistinct radials with slightly excavated, narrower interspaces; these are crossed by indistinct concentric threads, incremental lines, and occasional ridges due to resting stages; at what would be the intersections, if the concentric sculpture were better developed, the shell shows small, squarish nodulations which towards the ends and dorsal margins become minutely spinulose; the right valve has the hinge well developed, the anterior lateral

large and strong, the posterior obsolete; the posterior cardinal slightly grooved; margin with traces of crenulation anteriorly; scars normal. Height 27.0, length 29.0, diameter 12.0 mm.

Codakia orbicularis Linné.

Venus orbicularis Linné, Syst. Nat., ed. x., p. 688, 1758.
Venus tigerina var. Linné, Syst. Nat., ed. xii., p. 1134, 1767.
Cytherea tigerina Lamarck, An. s. Vert., v., p. 574 (*ex parte*, non *C. tigrina* Lam., *op. cit.*, p. 569), 1818.
Lucina tigerina Reeve, Conch. Icon., vi., *Lucina*, pl. i., fig. 3, 1850; not of Linné, 1758.
Lucina pusilla Gould, Proc. Bost. Soc. N. Hist., viii., p. 282, 1862 (nepionic shell)
Not *Lucina orbicularis* Sowerby, Geol. Trans., 2d Ser., iv., p. 341, pl. xvi., fig. 13, 1837; nor Deshayes, Expl. Sci. à la Morée, p. 95, pl. xxii., figs. 6, 8, 1836.
? = *Chama le codok* Adanson, Sénégal, p. 223, pl. xvi., 1757.

Pliocene marls of the Caloosahatchie and Shell Creek, Willcox, Dall, and Burns; Pleistocene of the West Indies and Florida Keys; recent from St. Augustine, Florida, and Bermuda, southward throughout the West Indies, the eastern shores of Central and the north shore of South America in shallow water.

This shell, well known under the erroneous name of *Lucina tigerina*, appears to have suffered no change whatever from Pliocene to recent time. The young nepionic shells are more inequilateral, more inflated, and in general of a very different aspect, so that it is not surprising that this stage, which is hardly to be discriminated from the same stage in species of Jagonia, should have been described by Dr. Gould as a distinct species.

Codakia (Jagonia) pertenera n. sp.

Plate 51, Figure 4.

Oligocene of the Bowden marls, Jamaica; Henderson and Simpson.

Shell rather large, very thin, with the surface more or less irregularly indented, as if from nestling; anterior end longer, attenuated; posterior end more plump, obscurely vertically truncate; beaks low; lunule long and very narrow, not deeply impressed; surface finely, closely, concentrically, and radially striated, but so feebly that no obvious cancellation results; hinge-margin narrow, hinge-teeth feeble, the laterals in the left valve obsolete or absent; scars lucinoid; margin sometimes smooth, sometimes obsoletely fluted. Height 32.5, length 35.0, diameter 13.5 mm.

This species is not a characteristic *Jagonia*, but is nearer to this group than to any other.

Codakia (Jagonia) textilis Guppy.

Lucina textilis Guppy, Proc. U. S. Nat. Mus., xix., p. 326, pl. xxx., fig. 1, 1896; not of Philippi, Abb. und Beschr. neue Conch., iii., p. 104, pl. ii., fig. 7, April, 1850.

Lucina costata Gabb, 1873; not of Orbigny, 1845.

Oligocene of Bowden, Jamaica.

This species is not unlike Philippi's *L. textilis,* also a *Jagonia,* a recent species. From *C. pertenera* Dall it differs in smaller size, more inflated and solid shell, stronger radials and marginal crenulation, and, in some specimens, distinct reticulation of the sculpture. I have some suspicion, however, that the two forms may prove to be extreme mutations of a single specific type, and for that reason do not propose a new specific name for the smaller fossil, which in that case would only form a dwarfish variety of *C. pertenera.* Some very young shells from the Oligocene at Gatun, Isthmus of Panama, may be nepionic specimens of the same species.

Codakia (Jagonia) Vendryesi n. sp.

PLATE 52, FIGURE 4.

Lucina pecten var. *antillarum* Guppy, MS. label in Guppy collection, U. S. Nat. Museum, No. 115657.

Lucina antillarum Gabb, Geol. St. Domingo, p. 251, 1873; not of Reeve, Conch. Icon., 1850.

Oligocene of the Bowden marl, Jamaica, West Indies.

This is the Oligocene analogue of the recent *Lucina antillarum* Reeve (=*L. costata* Orbigny, not Tuomey and Holmes), from which it differs in its more inequilateral shell, sharper and more distinctly reticulate sculpture, with finer and more thread-like radials, plumper and usually smaller shell. It is abundant in the Bowden marl, from which it was collected by Henry Vendryes, Esq., who sent it to Mr. Guppy, and subsequently by Messrs. Henderson and Simpson.

Codakia (Jagonia) erosa n. sp.

PLATE 52, FIGURE 7.

Oligocene of the Chipola marl, Chipola River, Florida; Burns.

Shell small, slightly inequilateral, moderately plump, suborbicular; beaks small and prominent; surface sculptured with a dozen or less obscure, hardly elevated, broad, flattish radials, corresponding to fascicles of radial threads in *C. Vendryesi,* crossed by incremental lines and near the base by somewhat more widely spaced concentric grooves; lunule lanceolate, moderately im-

pressed; hinge well developed, anterior right lateral present, the other laterals obsolete; margins rather strongly crenulate. Height 6.5, length 7.0, diameter 3.5 mm.

If this species grows to a larger size it is probable that the additional surface will be distinctly concentrically sulcate.

Codakia (Jagonia) sp. indet.

Oligocene of the lower bed at Alum Bluff and of the Chipola River, Florida.

Several specimens of a nepionic *Jagonia* distinct from any of the described species and resembling the delicately sculptured forms of *C. orbiculata*, but too young for positive identification, were obtained as stated, and another more strongly sculptured from the silex beds at Ballast Point, Tampa Bay.

Codakia (Jagonia) chipolana n. sp.

PLATE 52, FIGURE 9.

Oligocene of the lower bed at Alum Bluff, of the Chipola River, Calhoun County, and of Oak Grove, Santa Rosa County, Florida; Burns.

Shell rounded, slightly inequilateral, the posterior side shorter, moderately convex, with small, pointed, distinct, but not elevated beaks; sculpture of close-set, flattish, narrow, concentric ridges more distinct on the umbones and below the middle of the disk, crossed by numerous, even, non-bifurcate, radial grooves, whose interspaces are about as wide as the concentric ridges; the posterior area is set off by a wide, shallow sulcus, beyond which there are several radials, and the concentric sculpture becomes more or less lamellose; anteriorly, too, the radials become more pronounced, and there is a small, lanceolate anterior dorsal area; the lunule is subglobular, small, and deeply impressed; the hinge and marginal crenulations are strong, the anterior cardinals are effaced by the lunule and the scars are normal. Height 7.5, length 8.2, diameter 5.0 mm.

The well-defined dorsal areas and stronger distal sculpture throw a doubt on the proper place of this species, which in some respects recalls *Lucinisca*. It is a well-defined form and not uncommon in the Chipola marl.

Codakia (Jagonia) magnoliana n. sp.

PLATE 52, FIGURE 17.

Upper Miocene of Magnolia, Duplin County, North Carolina; Burns.

Shell small, thin, inequilateral, the beaks five-elevenths of the whole length

in front of the posterior end; both ends rounded, base arcuate, lunule narrow, lanceolate, no distinct dorsal areas; sculpture of numerous even, fine, close-set, rarely divaricate, similar radial riblets, crossed by fine, rounded, equal, close-set threads, narrower than the riblets, and which in crossing the latter are slightly arcuate convexly towards the beaks, making a very elegant though minute type of sculpture; hinge thin and delicate, but the teeth, especially the right laterals, very distinct; scars normal; margins delicately crenulate. Height 9.5, length 11.5, diameter 4.5 mm.

This species is of the fully differentiated *Jagonia* type and its sculpture is notably elegant.

Codakia (Jagonia) speciosa Rogers.

Lucina speciosa Rogers, Trans. Am. Phil. Soc., N. S., v., p. 333, pl. xxvi., fig. 6, 1837; not of Reeve, Conch. Icon., 1850.

Lucina squamosa Conrad, Fos. Med. Tert., p. 38, pl. xx., fig. 1, 1840 (not of Lamarck, 1818); Tuomey and Holmes, Pleio. Fos. S. Car., p. 57, pl. xviii., figs. 6, 7, 1857; Emmons, Geol. Rep. N. Car., p. 291, 1858.

Codakia speciosa Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 577, 1863.

Miocene of Virginia at Yorktown on the York River and City Point on the James River; upper Miocene of Magnolia and the Natural Well in Duplin County, North Carolina; of Darlington and the Ashley River limestone, South Carolina; Pliocene of the Caloosahatchie and Shell Creek, Florida; Willcox, Burns, and Dall.

This species resembles in a general way the *C. orbiculata* Montagu and passes through an analogous series of mutations, but the adults never attain the size of the recent species; they have a relatively somewhat larger lunule and coarser marginal crenulation; they are also usually somewhat less compressed.

On the whole, it seems best to retain Rogers' name for the shell, which is widely distributed through the upper Miocene and Pliocene of Virginia and southward, though I have not yet seen it from the typically cold-water Chesapeake Miocene of Maryland.

Codakia (Jagonia) orbiculata Montagu.

Venus orbiculata Montagu, Test. Brit. Suppl., p. 42, pl. xii., fig. 1, 1808; Dillwyn, Descr. Cat. Rec. Sh., i., p. 192, 1817.

Lucina squamosa Lamarck, An. s. Vert., v., p. 542 (after Enc. Méth., ii., pl. cclxxxv., figs. 3 a–c), 1818; not of Lamarck, Ann. du Museum, vii., p. 240, 1806.

Lucina pecten Lamarck, *op. cit.*, p. 543; Hanley, Rec. Shells, p. 348, pl. xiii., fig. 4 (after Delessert), 1856; not of authors.

Lucina imbricatula C. B. Adams, Proc. Bost. Soc. N. Hist., ii., p. 10, Jan., 1845.

Lucina occidentalis Reeve, Conch. Icon., vi., *Lucina*, pl. vii., sp. 35, errata, 1850.

Lucina obliqua Reeve, Conch. Icon., vi., *Lucina*, pl. viii., fig. 42, 1850, *fide* E. A. Smith, Chall. biv., p. 179, 1885; "Chusan" (?West Indies), but not of Defrance, Dict. Sci. Nat., v., p. 27, 1823.

Lucina pectinata C. B. Adams, Contr. Conch., p. 245, 1852; not of Gmelin, 1792, or Carpenter, 1857.

Not *L. pecten* Auct. of the Mediterranean (= *L. reticulata* Payr.) nor *L. orbiculata* Nyst.

Pleistocene of Barbados, Damon; of Cuba and other West Indian Islands, J. W. Spencer; of Curaçao and Venezuela, Martin.

This well-known shell probably occurs in the Pleistocene of the Florida Keys, and is found in the recent state from Bermuda to Brazil and also on the west coast of Africa. Its synonymy has been so much confused that it seemed well to include it here to clear up the name, since it is the type of *Jagonia* Récluz, and was described originally by Montagu as a British shell from an adventitious specimen. It is quite distinct from the true *Lucina pecten* of the Mediterranean described by Lamarck, though the name of *pecten* has frequently been applied to the West Indian species erroneously. It is possible that some of the well-marked varieties of this species will be eventually raised to specific rank, but at present I am obliged to regard them as varieties only, as noted in the above synonymy.

Codakia (**Jagonia**) **portoricana** Dall.

Codakia (*Jagonia*) *portoricana* Dall, Synopsis Lucinacea, Proc. U. S. Nat. Mus., xxiii., p. 822, pl. xxxix., fig. 6, 1901; Report Porto Rico Moll., Bull. U. S. Fish Com., i., p. 491, 1901.

Pliocene of the Caloosahatchie beds, Florida, Griffiths; living at San Juan and Mayaguez, Porto Rico, United States Fish Commission.

This curious little species is about half way between a typical *Jagonia* and a *Parvilucina*. It appears to be rare in the marls and was obtained only by Dr. Griffith, who presented specimens to the Wagner Institute.

Genus **LUCINA** (Bruguière) Lamarck.

Lucina Bruguière, Enc. Méth. Atlas, i., pl. cclxxxiv.–vi., 1797, name only.

Lucina Lamarck, Prodr. Class. Coq., p. 84, 1799; sole ex. *Venus edentula* Linné (? = *L. ovum* Reeve, 1850); Roissy, Sonnini's Buffon, vi., p. 371, 1805; Fischer, Man. de Conchyl., p. 1144, 1887; Cossmann, Cat. Illustr., ii., p. 32, 1887.

Anodontia Link, Beschr. Rostock Samml., p. 56, 1807; sole ex. *Venus edentula* Gmelin, vi., 3286; Chemnitz, Conch. Cab., vii., pl. xl., figs. 427–9, 1784, =*Tellina cryostoma* Meuschen, Mus. Gevers., p. 482, 1787, after Lister, Conch., pl. cclx., fig. 96.

Loripes of various authors, but not of Cuvier, 1817, after Poli, 1791.

>*Loripinus* Monterosato, Nat. Sicil., p. 91, 1883; Nom. Conch. Medit., p. 17, 1884; Cossmann, Cat. Illustr., ii., p. 47, 1887. Type *Lucina fragilis* Phil., Moll. Sicil., i., p. 34, 1836; = *Tellina gibbosa* O. G. Costa, 1836, + *Lucina bullula* Reeve, Conch. Icon., vi., *Lucina*, pl. x., fig. 35, 1850.

Shell inflated, thin, concentrically striated, anterior and posterior dorsal areas obsolete; lunule deep and narrow, no visible escutcheon; ligament and resilium deeply inset but not occluded; margins entire, anterior adductor scar long, hinge wholly edentulous. The following subgenus may be admitted:

Loripinus Monterosato. Shell with the ligament obsolete and the resilium wholly internal; the anterior adductor scar short and wide; otherwise like *Lucina*. Type *Lucina fragilis* Philippi. Mediterranean.

Lucina, in the strict sense, appears at least as early as the Eocene, is very abundant in the Oligocene, retreated before the colder Miocene waters, and increased again in the warmer climate of the Pliocene. The southern Pleistocene included, like the recent fauna, one or two species. The bullet-like internal casts of this genus are among the most characteristic fossils of the southern Tertiaries, their rounded form seeming to preserve them better than the more irregular and thinner casts of other genera.

Lucina subvexa Conrad.

Lucina subvexa Conrad, Fos. Tert. Form., p. 40, 1833; Am. Journ. Sci., 2d Ser., i., p. 403, pl. iv., fig. 14, 1846; not *Sphærella* (= *Diplodonta*) *subvexa* Conrad, 1838.

Cyclas subvexa Conrad, Am. Journ. Conch., i., p. 8, 1865.

Lucina (*Loripes*) *subvexa* Gregorio, Mon. Claib., p. 206, pl. xxix., fig. 14, 1890; Cossmann, Notes Compl., p. 12, 1894.

Lucina Dartoni Clark, Johns Hopkins Univ. Circ., xv., p. 5, 1895; Bull. U. S. Geol. Surv., No. 141, p. 79, pl. xx., figs. 2a–c, 1896.

Lucina ozarkana Harris, Bull. Am. Pal., ii., No. ix., p. 72, pl. xiv., figs. 7, a–b, 1897; Geol. Surv. Louisiana, v., p. 303, 1899.

Chickasawan Eocene of Wood's Bluff, Ozark, and the lower bed at Claiborne Bluff, Alabama; also in Arkansas and the Nanjemoy formation near Woodstock, Maryland; and the Claibornian at Claiborne Bluff and Garland's Creek, Alabama; and in Clarke County, Mississippi.

This is a typical *Lucina* except that the concentric threading is more prominent and dense and the radial striation more sharp than in succeeding members

of the genus. These characters, which belong to the undifferentiated types of the Eocene, gradually fade out until the recent species of *Lucina* have only incremental concentric sculpture, and the radial striation is entirely, or almost entirely, absent.

The young specimens of this species are very delicate shells, on which the concentric threads are more distant than in the portion of the shell subsequently formed, and the radial sculpture very marked, so that at first sight they appear quite distinct from the adults, which are abundant but poorly preserved in the lower bed at Claiborne Bluff. It is to this immature form that the names given by Clark and Harris apply.

Lucina sp. indet.

Internal casts of a species of *Lucina* sixty-five millimetres long and more inflated than *L. subvexa* were obtained by Burns on Stout's Creek, eight miles below Fort Mott, Orangeburg County, South Carolina, in strata said to be Eocene. They are too imperfect for description. What may be the same species, also represented only by internal casts, has been received from limestones of Claibornian age near the iron mines of Santiago de Cuba in the railway cut two hundred and fifty feet above the sea, in beds of uncertain, possibly Eocene, age on the islands of St. Kitts and Trinidad, West Indies, and from the Oligocene horizon at Clairmont, St. Ann's, on the island of Jamaica. This last specimen seems more profusely concentrically striated externally and somewhat less inflated than those previously mentioned and may belong to a distinct species. It would probably belong to the same horizon as beds containing a profusion of similar casts, badly preserved, at Chattahoochee Junction, where the railway bridge crosses the Chattahoochee River near the Georgia-Florida boundary line.

Lucina janus n. sp.

PLATE 51, FIGURE 9.

Oligocene of Chipolan age at Sopchoppy Creek, Wakulla County; Preston Sink; the Chipola River; the lower bed at Alum Bluff on the Chattahoochee River, and in Walton County, Florida.

Shell orbicular, plump, nearly equilateral; beaks low, slightly prosogyrate over a small, deeply impressed, narrowly lanceolate lunule; anterior hinge-line somewhat ascending, suddenly rounding into the curve of the anterior end, forming an ill-defined wing, which has irregular marks of compression where it joins the body of the shell; the posterior dorsal descends slightly in a right

line, meeting the curve without any angle or alation; base nearly semicircular; surface, when perfect, somewhat shining, with very fine, rather irregular concentric wrinkles and incremental lines, which cross fine, microscopic, slightly vermicular, radial striation all over the shell; hinge edentulous; posterior adductor scar lucinoid but rather short. Height of an average specimen 37, length 42, diameter 25 mm.

This species is very abundant in the Chipola formation. The radial sculpture is less evident than in *L. subvexa*, the surface is smoother, and the shell less inflated.

Lucina corpulenta n. sp.

PLATE 51, FIGURES 7, 8.

Oligocene of the Chipola beds on the Chipola River, Florida; Burns.

This form resembles the *L. janus*, but is more inflated, with more elevated and incurved beaks, a shorter and smaller lunule, and no anterior alation. Height 35, length 42, diameter 30 mm. A fragment of a specimen, probably of this species, is 80 mm. in length.

Lucina santarosana n. sp.

PLATE 51, FIGURE 6.

Upper Oligocene of the Oak Grove sands, at Oak Grove, Santa Rosa County, Florida; Burns.

Shell much resembling *L. janus*, but with the beaks slightly more anterior, the posterior dorsal area distinct, the anterior more emphatic, the concentric striation stronger, the lunule shorter and wider, and the surface retaining traces of four or five color zones alternately lighter and darker. The scar of the posterior adductor is also rather longer. Height 36, length 41, diameter 25 mm. A large fragment is 65 mm. long, and the interior, except in the middle of the disk, is rather conspicuously radially striate. The best preserved specimens show a fine, even, concentric lamellation on the dorsal areas.

Lucina chrysostoma (Meuschen) Philippi.

Tellina crysostoma Meuschen, Mus. Gevers., p. 482, 1787 (err. typ.).

Lucina chrysostoma Philippi, Abb. und Beschr. neue Conchyl., ii., p. 206, pl. i., fig. 3, 1847.

Venus edentula Chemnitz, Conch. Cab., vii., pl. xl., figs. 427–9, 1784; Gmelin, Syst. Nat., vi., p. 3286, 1792; not of Linné, Syst. Nat., ed. x., p. 689, 1758.

Anodontia alba Link, Beschr. Rostock Samml., p. 56, 1807.

Lucina edentula Reeve, Conch. Icon., *Lucina*, pl. ii., fig. 9, 1850; Heilprin, Trans. Wagner Inst., i., pp. 102–3, 1886.

Loripes chrysostoma Arango, Fauna Mal. Cubana, p. 257, 1878.

Pliocene of the Caloosahatchie, Shell Creek, and Alligator Creek, south Florida, Willcox and Burns; Pleistocene of Barbadoes, Damon; of the Florida Keys, Dall, and of various localities in the West Indian region; recent on the coast of Florida and in the West Indies in shallow water.

This well-known shell, the "Apricot" of the eighteenth century collectors, occurs abundantly in the Floridian Pliocene, exactly agreeing with recent specimens. It is not uncommonly referred to the genus *Loripes* under a mistaken idea of what *Loripes* really is, and it is the *edentula* of Chemnitz, a name very generally adopted, but not the *edentula* of Linné, many years earlier.

Lucina Philippiana Reeve.

Lucina Philippiana Reeve, Conch. Icon., *Lucina*, pl. v., figs 23 a–b, 1850.

Lucina edentula Philippi, Abb. und Beschr. neue Conchyl., ii., p. 205, pl. i., fig. 1, 1847; not of Linné or Reeve.

Lucina Schrammi Crosse, Journ. de Conchyl., xxiv., p. 166, 1876; *ibid.*, xxvi., p. 328, pl. x., fig. 6, 1878.

Pleistocene of Barbados, Damon; recent in the West Indies and the Gulf of Mexico.

This large, chalky-white species bears to the *L. chrysostoma* much such a relation as *L. corpulenta* Dall bears to *L. janus* Dall in the Chipolan beds.

Genus **LORIPES** Cuvier.

>*Loripes* + *Tellina* Poli, Test. Utr. Sicil., i., p. 31, 1791; ii., p. 47, 1795. Type *Tellina lactea* Poli.

>*Loripoderma* Poli, ii., p. 253, 1795; same type.

<*Loripes* Oken, Lehrb. d. Naturg., iii., pp. 231, 848, 1815.

= *Loripes* Cuvier, Règne Anim., ii., p. 482, 1817, sole ex. *Tellina lactea* Poli; Bowdich, Elém. Conch., ii., p. 9, 1822; Gray, List Brit. An., p. 100, 1851; H. and A. Adams, Gen. Rec. Moll., ii., p. 468, 1857.

Not *Loripes* Schweigger, Handb. Naturg., p. 705, 1820, = *Omala* Schumacher, 1817.

Lucina (sp.) Lamarck, An. s. Vert., v., p. 543, 1818.

Thyatira Gray (as of Leach), Ann. Mag. Nat. Hist., xx., p. 272, 1847 (not of Hübner), *Tellina leucoma* Turton.

Amphidesma sp. Lamarck, *op. cit.*, 1818.

Ligula Menke, Syn. Meth. Moll., p. 112, 1830; not of Montagu, 1808.

Loripes (sp.) Menke, *op. cit.*, 1830.

Lucinida Orbigny, Voy. Am. Mér., p. 588, 1846. Type *L. cryptella* Orbigny, *op. cit.*, plate lxxxiv., figs. 18–20 + *L. brasiliana* Orbigny, *op. cit.*, in legend to plate; + *L. brasiliensis* Philippi, Zeitschr. Mal., 1848, p. 150; not *Diplodonta brasiliensis* Mittré, Journ. de Conchyl., i., p. 242, 1850.

Thiatisa Gray, P. Z. S., 1847, p. 195, No. 682, not 680.
Lucinidea Barrois, in Zittel, Traité de Pal., ii., p. 95, 1887 (err. typ.?).

Shell tumid or compressed, suborbicular, with feeble sculpture; lunule narrow, elongate, an obscure anterior dorsal area indicated, but no posterior area or escutcheon; ligament almost or wholly internal, obsolete; the resilium deeply immersed; hinge with the posterior laterals and right anterior cardinal usually absent; margins entire, anterior adductor scar long and narrow; dental formula $\frac{\text{L. r1010.}}{\text{R. r0100.}}$.

The type of this genus is the *Tellina lactea* of Gmelin and Lamarck, but not of Linné, whose shell, represented by his original type, is the *Diplodonta globosa* of Forskål (as *Venus*), It. obs., p. 53, No. 122, 1780 (Chemnitz, Conch. Cab., vii., p. 36, pl. xl., figs. 430–31, 1784). The name of Gmelin, being preoccupied by Linné, should be rejected, and the species denominated *Loripes lucinalis* (Lamarck, An. s. Vert., v., p. 49, 1818), that being the specific name next in date. Other synonyms are *Lucina leucoma* Turton, Dithyra Brit., pp. 112–13, pl. vii., fig. 8, 1822; *L. amphidesmoides* Deshayes, Enc. Méth., ii., p. 375, 1830; *Thyatira lactea* Gray, Ann. Mag. N. Hist., xxii., p. 272, 1847; *Lucina lacteoides* Deshayes, Expl. Sci. Algerie, pl. lxxx., figs. 1–4, 7, 8, 1848; and *Lucina elata* Locard, Coq. Mar. de France, p. 313, 1892.

The genus *Megaxinus* Brugnone, which has some resemblance to *Loripes*, has been placed as a synonym under it by several authors. By the examination of specimens kindly lent by the Marquis de Monterosato and received by him from Brugnone, I have been able to determine that this shell is Thyasiroid and not Lucinoid. It differs from the typical *Thyasira* only by the greater development of the ligament and resilium, which are strong and set upon strong nymphs and set deeply in an impressed, narrow escutcheon, somewhat as is the ligament in *Codakia*. The hinge is edentulous and the other characters recall *Thyasira*, and I have accordingly referred it to that family as a synonym of *Thyasira*. It has an anterior angle as in *T. bisecta*, a rather deep lunule, and only incremental sculpture. The ligament was not covered, as it is in *Loripes*, and neither ligament nor resilium are truly internal.

Though there are some American recent species, so far none has been found fossil in our Southern Tertiaries.

Genus MYRTÆA Turton.

Myrtæa Turton, Dithyra Brit., p. 133, 1822. Sole ex. *Venus spinifera* Montagu, Test. Brit., p. 577, pl. xvii., fig. 1, 1803; Gray, List. Brit. An., p. 98, 1851; H. and A. Adams, Gen. Rec. Moll., ii., p. 468, 1857.

Cyrachæa Leach, Moll. Gt. Brit., p. 314, 1852, *Lucina spinifera* Montagu; Ann. Mag. Nat. Hist., xx., p. 272, 1847 (name only).

Ortygia (sp.) Brown, Ill. Conch. Gt. Brit., pl. xix., figs. 14–15, 1827.

Myrteopsis Sacco, Terz. Piem. Lig., xxix., p. 96, 1901; *M. taurolævis* Sacco, *loc. cit.*

Shell elongate-oval or subrectangular, moderately convex or compressed, dorsal areas obsolete, the sculpture of the disk chiefly concentric and lamellar; the sculpture less pronounced in the middle of the disk and frequently exhibiting a serrate appearance when the lamellæ cross the bounding carina of lunule or escutcheon; internally with the left laterals usually obsolete and only one right cardinal tooth; cardinals entire; ligament and resilium deep-set but not internal; anterior adductor scar lucinoid but rather short; inner margins entire.

This group is paralleled in *Phacoides* by several others which want the anterior right cardinal in the adult, but in *Myrtæa* the single right cardinal seems to be normal, while in the subdivisions of *Phacoides* its absence is due to degeneration during the growth of the individual or to the dynamic results of the inthrusting of the lunule, which occupies the space where the anterior cardinal would otherwise develop.

A subgenus of *Myrtæa,* under the name of *Myrteopsis,* has been proposed, imperfectly described and unrecognizably figured by Sacco. Not having any sufficient data in relation to the hinge, I place it as a section of *Myrtæa,* following the author who proposed it, but accept no responsibility for this arrangement. No authority and no reference is given by Sacco in his "Memoir" for the type, which is not figured or described in that work, but he figures very obscurely another species, *M. magnotaurina* Sacco (*loc. cit.,* p. 96, pl. xxi., figs. 32–36) from the Italian tertiaries.

Three sections may be discriminated:

Myrtæa s. s.

Sculpture wholly concentric.

?Myrteopsis Sacco.

Larger; teeth feeble or obsolete, surface smooth.

Eulopia Dall, 1901.

Shell with radial vermiculate sculpture between concentric lamellæ; usually of small size. Type *Lucina sagrinata* Dall, Proc. U. S. Nat. Mus., xii., p. 263, pl. xiv., fig. 11, 1887.

The radial sculpture of the species of this section recalls that of the early representatives of the genus *Lucina* s. s., in the Oligocene and Eocene, which the later species of *Lucina* appear to have lost.

Myrtæa curta Conrad.

Cyclas Curta Conrad, Am. Journ Conch., i., p. 8, 1865 (name only); pp. 139, 212, pl. xx., fig. 14, 1865 (Jacksonian).

Lucina curta Conrad, S. I. Checkl. Eoc. Fos., p. 24, 1866.

Lucina choctavensis O. Meyer, Bull. Ala. Geol. Surv. No. 1, p. 81, pl. i., fig. 28, 1886 (Vicksburgian).

Lucina Uhleri Clark, Johns Hopkins Univ. Circ., xv., p. 5, 1895; Bull. U. S. Geol. Surv. No. 141, p. 79, pl. xxi., figs. 1 a–1 d, 1896; Maryl. Geol. Surv., Eocene, p. 176, pl. xxxvii., figs. 4–7, 1901.

Lucina Ulrichi Harris, Bull. Am. Pal. No. 9, p. 71, pl. xiv., fig. 4, 1897 (lapsus for *Uhleri*). Chickasawan.

Eocene and Oligocene from Chickasawan to Vicksburgian. Wood's Bluff and lower bed at Claiborne Bluff, Alabama; Montgomery, Louisiana; Jackson, Garland's Creek, Ucutta Creek, Carson's Creek, Wahtubbee Hills, and Red Bluff, Mississippi; Jacksonian of Arkansas; Aquia and Nanjemoy formations at numerous localities in Maryland.

Specimens from many localities do not seem to differ even varietally from the Chickasawan horizon to the Vicksburgian, but so far I have seen no specimens from the Claibornian.

Myrtæa limoniana n. sp.

Plate 52, Figure 10.

Oligocene of Bowden, Jamaica; Pliocene of Limon, Costa Rica.

Shell small, thin, subequilateral, somewhat longer than high, only moderately convex, though hardly compressed; beaks small and low; lunule depressed, narrow, sublanceolate, small; surface covered with fine, sharp, thin, elevated, concentric lamellæ, separated by wider interspaces and more elevated near the dorsal margins, especially behind the beaks, where in perfect specimens five or six of them are produced as small leaflets, which, however, are usually broken off; hinge with a single right and two left cardinal teeth, the laterals obsolete; scars normal; the margin of the valves entire. Alt. 8, lon. 9, diam. 4 mm.

This species, though very similar, is more elongated, less elevated, and more densely lamellose than *M. curta*. From the *M. pristiphora* Dall and Simpson, the recent representative of the group in the West Indies, it differs by its more quadrate-elongate form, thinner shell, and more delicate and sparser concentric lamellæ.

Myrtæa (Eulopia) furcata n. sp.

PLATE 52, FIGURE 13.

Oligocene of the Bowden, Jamaica, marl; Henderson and Simpson.

Shell thin, rounded, moderately convex, subequilateral; beaks low, inconspicuous; lunule long and narrow, moderately impressed, escutcheon almost linear, bordered outwardly by a carina; surface near the beaks with delicate, distant, slightly elevated concentric lines which become almost obsolete over the middle and basal portions of the disk; radial sculpture of fine, close-set, rather flattish threads, which towards the margins bifurcate and form a rather widely divaricate and somewhat irregular sculpture; hinge delicate, the right laterals feeble, ligamentary groove distinct, rather short; the adductor scars large, normal; the margins of the valves entire. Alt. 11.5, lon. 13, diam. 5 mm.

This is larger, more delicate, and thinner than most of the group. *Lucina astartæformis* Aldrich, 1897, from the Claibornian of Alabama and the Nanjemoy formation of Maryland, is a species of *Eulopia.*

Myrtæa (Eulopia) vermiculata n. sp.

PLATE 52, FIGURE 5.

Oligocene of the Bowden, Jamaica, marl, Henderson and Simpson; Ballast Point, Tampa Bay, Florida, Dall.

Shell resembling *M. sagrinata* Dall, but shorter and more rounded; moderately convex, subequilateral, the anterior end slightly longer; beaks low and inconspicuous; lunule narrow, concavely excavated; the escutcheon linear, longer; both bounded externally by a serrate carina; ligamentary groove about half as long as the escutcheon; surface with slightly elevated, thin, concentric lamellæ, the interspaces radially sculptured with close-set vermiculate threads; hinge with the normal cardinal dentition and distinct right laterals; adductor scars rather small, the interpallial area punctate. Alt. 6.5, lon. 7.5, diam. 3.5 mm.

Genus **PHACOIDES** Blainville.

Phacoides Blainville, Man. Malac., i., p. 540, 1825; sole ex. *Lucina jamaicensis* Lamarck, Enc. Méth., pl. cclxxxiv., fig. 2.

Lucina Lamarck, Syst. An. s. Vert., p. 124, 1801; not Lam., 1799; H. and A. Adams, Gen. Rec. Moll., ii., p. 466, 1857.

>*Lucina* Schumacher, Essai, p. 164, 1817, ex. *L. pensylvanica* Lam.

<*Egraca* Leach (olim), Moll. Gt. Brit., p. 210, 1852; = *Lucina* Lam., 1818.

>*Miltha* H. and A. Adams, Gen. Rec. Moll., ii., p. 468, 1857; sole ex. *Lucina Childreni* Gray, Zoöl. Journ., i., p. 221, 1825; Thomson's Ann. Phil., xxv., p. 136, 1825 (as *Tellina*).

>*Milthea* Meek, Inv. Fos. Up. Missouri, p. 131, 1876 (err. typ.).

>*Miltha* Cossmann, Cat. Illustr., ii., p. 30, 1887; Fischer, Man. de Conchyl., p. 1143, 1887.

>*Pseudomiltha* Fischer, Man. de Conchyl., p. 1144, 1887. Type *Lucina gigantea* Deshayes, Coq. Fos. env. de Paris, i., p. 91, pl. xv., figs. 11, 12, 1824.

>*Triodonta* Gray, List Brit. An., p. 97, 1851; not of (Schumacher, 1817, em.) Agassiz, Nomenclator, p. 1087, 1848.

?*Austriella* Tenison Woods, Trans. Roy. Soc. Victoria, Melbourne, xvii., p. 82 (*A. sordida*), 1881; Tryon, Syst. Conch., iii., p. 211, 1884.

>*Here* Gabb, Pal. Cal., ii., pt. i., p. 29, 1866; pt. ii., p. 100, 1869. Type *Lucina Richthofeni* Gabb, *loc. cit.*, pl. viii., fig. 49.

>*Linga* de Gregorio, Bull. Soc. Malac. Ital., x., p. 217, 1885. Type *Lucina columbella* Lamarck.

>*Cavilucina* Fischer, Man. de Conchyl., p. 1143, 1887. Type *Lucina sulcata* Lam.; Cossmann, Cat. Illustr., ii., p. 35, 1887.

>*Dentilucina* Fischer, Man. de Conchyl., p. 1143, 1887. Type *Lucina jamaicensis* Lamarck; Cossmann, Cat. Illust., ii., p. 36, 1887.

>*Cardiolucina* Sacco, Terz. Piem. Lig., xxix., p. 89, 1901 (*Lucina Agassizi* Mich.).

This genus comprises most of the shells formerly included in the genus *Lucina* in a wide sense. Owing to the numerous modifications and combinations which it exhibits, it is necessary for clearness to recognize a number of subdivisions. In Leach's "Mollusca of Great Britain" he states that he had proposed to call the shells denominated *Lucina* by Lamarck by the name of *Egraca,* but, not having published this name, he adopts that of Lamarck. I have, therefore, as no type was mentioned, regarded Leach's *Egraca* (1852) as an exact synonym of *Lucina* Lamarck *senso lato.*

Tridonta Schumacher was founded on *Astarte borealis,* but owing to a confusion between the *Venus* (*Astarte*) *borealis* of Chemnitz and the *Venus* (*Lucina*) *borealis* of Linnæus the name has crept into the Lucinoid synonymy.

A curious brackish-water shell from Australia was imperfectly described and obscurely figured by Tenison Woods in 1881 under the name of *Austriella.* He referred it to the *Unionidæ,* but from the appearance of the figure Tryon supposed it might be Lucinoid. More information is needed before its place can be definitely ascertained.

The following subdivisions of the genus seem warranted by the shell characters:

Subgenus *Phacoides* Blainville s. s. Type *Lucina jamaicensis* Lamarck.

Shell lentiform, with strong dorsal areas and chiefly concentric sculpture, the cardinal teeth obsolete in the adult but the laterals well developed.

Subgenus *Here* Gabb. Type *Lucina Richthofeni* Gabb (+ *Lucina* Schum., 1817, non Lam., 1799; + *Linga* Greg., 1885 + *Cardiolucina* Sacco, 1901).

Shell globose, solid, with strong, concentric sculpture and developed dorsal areas, the lunule often deeply impressed and the right anterior cardinal effaced, the other teeth usually well developed.

Section *Gradilucina* Cossmann, 1902. Type *Lucina tabulata* Deshayes. Eocene of Paris.

Shell small, inflated, with numerous stout concentric waves; lunule large but feebly defined; escutcheon obsolete; hinge-teeth well developed; inner margins entire.

Deshayes' specimen of the right valve has the hinge apparently diseased or abnormal, since there is no socket in the hinge of the left valve, as figured, capable of holding the egregious anterior lateral of the former.

Section *Pleurolucina* Dall, 1901.

Shell with a small number of large radial ribs in addition to the concentric sculpture. Type *Lucina leucocyma* Dall, 1886, Proc. U. S. Nat. Mus., xii., p. 263, pl. xiv., figs. 6, 7, 1889.

Section *Cavilucina* Fischer, 1887. Type *Lucina sulcata* Lamarck.

Shell small, compressed, concentrically striated, the areas and teeth more or less obsolete; the lunule small and often deep.

Subgenus *Lucinisca* Dall, 1901. Type *Lucina nassula* Conrad.

Shell lentiform, white, with well-marked dorsal areas, the sculpture reticulate and muricate, the right anterior cardinal obsolete.

Subgenus *Miltha* H. and A. Adams, 1857. Type *Lucina Childreni* Gray. Gulf of California.

Shell solid, usually compressed, concentrically striate, with a conspicuous periostracum, narrow impressed lunule, inconspicuous anterior and posterior dorsal areas, deeply inset ligament and resilium; hinge with two cardinals in each valve, the inner pair bifid; margins entire; anterior adductor scar prolonged; the valves sometimes diversely convex.

Only two recent species of this type are known, but there are numerous fossil species.

Subgenus *Pseudomiltha* Fischer, 1887. Type *Lucina gigantea* Deshayes. Parisian Eocene.

Shell like *Miltha,* but with the hinge-teeth wholly obsolete and the valves often less solid and more convex.

Recent species occur at Panama and in the Gulf of Mexico. The fossils comprise some of the largest of the *Lucinacea.*

Subgenus *Lucinoma* Dall, 1901. Type *Lucina filosa* Stimpson.

Shell usually large, lentiform, white with a conspicuous periostracum, concentrically lamellose or striated; the cardinal teeth developed, the inner pair usually bifid, the laterals obsolete or absent; the inner margins entire.

This is a well-marked group with a wide extension in time and geographically, preferably inhabiting cold water and frequently great depths.

Subgenus *Callucina* Dall, 1901. Type *Lucina radians* Conrad.

Shell orbicular, dosinoid, concentrically filose and sometimes with feeble radial sculpture; the dorsal areas obsolete; the lunule small, comprised chiefly in one valve and fitting when closed into a recess in the other valve; hinge with one cardinal in each valve, the other teeth feeble or absent; inner margins crenulate.

Section *Epilucina* Dall, 1901. Type *Lucina californica* Conrad.

Shell veneriform, convex, all the hinge-teeth developed, inner margins entire; otherwise like *Callucina.*

Subgenus *Parvilucina* Dall, 1901.

Shell small, plump, often inequilateral; sculpture more or less reticulate but not muricate; teeth small, but usually all present.

Section *Parvilucina* s. s. Type *Lucina tenuisculpta* Carpenter.

Dorsal areas obscure or obsolete, sculpture feeble.

Section *Bellucina* Dall, 1901. Type *Lucina pisum* Reeve (Aug., 1850, not of Philippi, April, 1850, nor of Sowerby, 1837, nor Orbigny, 1841) = *Parvilucina eucosmia* Dall, 1901.

Dorsal areas and sculpture strong.

Of those early species, which, though usually having the cardinal teeth persistent, may perhaps best be referred to the typical section of this genus, there are but few in our Tertiaries, of which *P. Turneri* Stanton, 1897,* from the Tejon of California; *P. fortidentalis* Harris, 1896,† from the Midway horizon of Georgia and Alabama, and *P. papyraceus* Lea, 1833,‡ from the

* Seventeenth Ann. Rep. U. S. Geol. Survey, part i., p. 1042, pl. lxvi., figs. 6, 7.
† Bull. Am. Pal., iv., p. 69, pl. vi., figs. 11, 11a. ‡ Contr. Geol., p. 58.

Eocene at Claiborne Bluff and Wood's Bluff, and the Jacksonian of Choctaw County, Alabama, are well-established species. *Lucina estrellana* and *L. tetrica* Conrad, 1857, are unidentifiable Californian fossils of unknown horizon.

Only two species of the typical section remain to be particularly mentioned.

Phacoides domingensis n. sp.

PLATE 50, FIGURE 11.

Oligocene of the Bowden horizon on the island in Lake Henriquillo, St. Domingo; at Bowden, Jamaica, and Ballast Point, Tampa Bay, Florida.

Shell closely resembling *P. pectinatus* (for which it has been taken by Guppy), but smaller, more inflated, with the notch in front of the anterior dorsal area more indented and angular, the concentric lamellation more distant and more evenly spaced, and the posterior dorsal area shorter in proportion and more triangular. Alt. 31, lon. 34, diam. 19 mm.

This is with little doubt the Oligocene precursor of *P. pectinatus,* and was regarded as identical with it by Gabb and Guppy.

Phacoides pectinatus Gmelin.

Venus jamaicensis Chemnitz, Conch. Cab., vii., p. 24, pl. xxxix., figs. 408–9, 1784 (after Lister, pl. ccc., fig. 137), non-binomial; Dillwyn, Descr. Cat. Rec. Sh., i., p. 193, 1817.

Tellina pectinata Gmelin, Syst. Nat., vi., p. 3236, No. 41, 1792; Wood, Gen. Conch., p. 169, 1815; Index Test., pl. iv., fig. 44, 1828.

Tellina jamaicensis Spengler, Skrift. Naturf. Selsk. Kjöbn., iv., pt. ii., 1798.

Tellina scabra Chemnitz, Conch. Cab., xi., pp. 207–8, pl. cxcix., figs. 1943–4, 1799 (?); Wood, Gen. Conch., p. 184, 1815; Dillwyn, Descr. Cat. Rec. Sh., i., p. 96, 1817.

Lucina (Phacoides) jamaicensis Blainville, Man. Mal., i., p. 540, 1825.

Lucina scabra Gray, Thomson's Ann. Phil., xxv., i., p. 136, 1825.

Lucina jamaicensis Lamarck, An. s. Vert., v., p. 539, 1818 (Enc. Méth. Vers., ii., pl. cclxxxiv., figs. 2 a–c); Reeve, Conch. Icon., vi., *Lucina,* pl. vii., fig. 7 a–b, 1850.

Lucina funiculata Reeve, Conch. Icon., vi., *Lucina,* pl. vii., fig. 40, 1850.

Not *L. pectinata* C. B. Adams, Proc. Bost. Soc. N. Hist., ii., p. 228, 1847 (name only); Contr. Conch., p. 245, Nov., 1852; nor of Carpenter, Mazatlan Cat., p. 98, 1857.

Pliocene of the Caloosahatchie, Shell Creek, Alligator Creek, and the Myakka River, south Florida; Pleistocene of south Florida and the Antilles, and of the north coast of South America; recent from St. Augustine, Florida, southward, throughout the Antillean region and along the east coast of South America as far as Montevideo, Uruguay.

This species, which is better known by the later name of *jamaicensis* applied by Spengler after the non-binomial Chemnitz, was reported in 1841 by Conrad

as among the species still living which occur in the upper Miocene of the Natural Well in Duplin County, North Carolina. In the extensive collections made at this locality by Burns and others it has not been found, and I am inclined to regard the identification of Conrad as due to some mixture of specimens or error of naming.

Subgenus HERE Gabb.

This group is profusely represented in the Eocene, where it may be observed that the species in some cases exhibit a very exceptional variability in surface sculpture as well as outline, and suggest in their variations the subdivisions which only become differentiated permanently later in the history of the family. A number of these species were named almost simultaneously by Conrad and Lea. The former gave brief diagnoses of a few lines only without measurements or figures, and in some cases the forms intended are unidentifiable. Lea, on the other hand, gave careful descriptions and excellent figures. In the cases where no identifiable figure or description was given by Conrad until after the publication of Lea's "Contributions to Geology," it would seem that both the rules of justice and of nomenclature require the retention of Lea's name.

Phacoides (*Here*) *pomilius* (Conrad, 1833) is identical with *Lucina impressa* Lea, 1833; *L. pompilia* (*lapsus*) Conrad, 1866; *L. bisculpta* O. Meyer (young), 1886; *L. sublævigata* Gregorio, 1890; *L. postsulcata* Gregorio, 1890, and *L. amica* Gregorio, 1890. It is Claibornian and earlier. *P.* (*H.*) *cariniferus* (Conrad, 1833) has for synonym *Lucina cornuta* Lea, 1833, also Claibornian. *P.* (*H.*) *dolabra* (Conrad, 1833) is the same as *Astarte recurva* Lea, 1833, with the preceding.

Of the section *Cavilucina*, *P. alveatus* (Conrad, 1833) is identical with *Lucina lunata* Lea, 1833, + *Lucina modesta* (Conrad, 1846, young), + *Lucina subcuneata* Gregorio, 1890. *P. rotundus* (Lea, 1833, + *L. symmetrica* Conrad, 1833, not identifiable from original description). Both are Claibornian and Chickasawan. A third species from the Aquia formation of Virginia is *P. aquianus* (Clark, 1895), of which *P. Greggi* Harris, 1897, seems to be a variety from the Chickasawan of Alabama.

Phacoides (Here) hamatus n. sp.

Plate 50, Figure 9.

Eocene of the lower bed at Claiborne Bluff, Alabama; Lea.

Shell small, plump, with small, high, prosogyrate beaks; dorsal areas strongly emphasized by an impressed sulcus on their ventral margins which

terminates distally in an indentation of the margin which, as it were, loops up the line of the profile; surface sculptured with incremental lines and regularly spaced, rather distant, slightly elevated and recurved concentric lamellæ; lunule small, cordate, deep, overshadowed by the gyrate umbones; escutcheon none; anterior end of the valve below the anterior dorsal area projecting, subangular; hinge and adductor scars normal. Height 13.5, length 14.0, diam. 10.0 mm.

This shell is near *P. cariniferus* Conrad, but is less solid, less inflated, with the concentric sculpture more distinct and distant, the dorsal areas larger and more emphatically impressed, and the margin of the valves smooth, not crenulate.

Phacoides (Here) wacissanus n. sp.

Plate 50, Figure 15.

Oligocene of the silex beds at Ballast Point, Tampa Bay, and Wacissa, Jefferson County, Florida; Crosby, Burns, Shepard, Dall, and Eldridge.

Shell much resembling in general appearance and solidity *P. cariniferus,* but having the beaks lower, the posterior dorsal area larger but not so deeply impressed, the anterior dorsal area less impressed, larger, and without the carina and marginal projection below it which occurs in that species; the shell is also rather longer and less high, and the hinge-teeth are longer and heavier than in *P. cariniferus.* The margins are finely crenulate, and well-grown specimens often exhibit resting stages near the base, indicated by sulci. Alt. 15, lon. 16, diam. 12 mm. Large specimens attain a length of 20 mm.

Rather common in the silex beds at Ballast Point.

Phacoides (Here) podagrinus n. sp.

Plate 50, Figures 12, 13.

Oligocene of the Bowden, Jamaica, marl, and of beds of similar age at Curaçao.

Shell when young moderately convex, when senile having an exaggerated thickness and almost spherical convexity. It belongs to the group of *P. pensylvanicus* L., of which species it is doubtless a precursor, and the mention of that species by Gabb and Guppy in the "Miocene" (= Oligocene) of St. Domingo and Jamaica doubtless refers to the present fossil. For this reason it is best described by comparison with *P. pensylvanicus,* from which it differs by its smaller size and greater inflation at maturity, its finer and closer concentric sculpture, its shorter and broader posterior dorsal area, its less elevated beaks, its slightly smaller and more distinctly limited anterior dorsal area, and its more

nearly circular outline. Alt. 28, lon. 28, diam. 30 mm. The largest specimen observed has a length of 42 and a diameter of 35 mm., while a specimen of *P. pensylvanicus* of the same size has a diameter of only 25 mm.

The cardinal teeth of the fossil are also much more clear-cut than in the recent shell, in which the two smaller cardinal teeth are usually very obscure or even obsolete in adult specimens.

Phacoides (Here) Glenni n. sp.

Plate 50, Figure 17.

Oligocene of the Chipola beds on the Chipola River, and of the lower bed at Alum Bluff on the Chattahoochee River, Calhoun County, Florida; Burns and Dall.

Shell of moderate size and convexity, solid, polished, with small prosogyrate rather elevated beaks, rounded or subovate outline, and strongly marked dorsal areas; the young begin with a subrhomboidal shell, in which the projecting anterior and posterior ends recall *P. cariniferus;* the exterior is elegantly and rather closely concentrically rippled; the lunule is deep and cavernous, much more excavated in proportion than in the adult, and the dorsal areas are larger in proportion to the whole shell. In the course of growth the concentric sculpture becomes feebler and more distant, the strong, cord-like carina below the centrally convex anterior dorsal area becomes less conspicuous, and the outline of the valve changes to subovate, rather higher than long, and the lunule is so obscured by the gyrate beaks that it is no longer noticeable. An average specimen measures: alt. 32, lon. 30, diam. 16 mm.

The margins are elegantly minutely crenulate. The shell is named in honor of Professor L. C. Glenn, who has done much work on the Tertiaries of Maryland and Virginia.

Phacoides (Here) tithonis n. sp.

Plate 50, Figure 10.

Oligocene of the Bowden, Jamaica, marl, collected by Messrs. J. B. Henderson, Jr., and Charles T. Simpson.

Shell small, rotund, with rather prominent beaks, the dorsal areas not distinguished by sculpture and indicated only by faint, broad, radial sulci; lunule small and deep, no escutcheon visible; surface with profuse, elevated, rather unevenly spaced, concentric lamellæ; hinge well developed; margins minutely crenulated. Alt. 4.0, lon. 4.5, diam. 3.8 mm.

This little shell, represented only by a single valve, is apparently the pre-

cursor of *P. sombrerensis* Dall, a recent species from Antillean waters, which is, however, larger, with more regular concentric sculpture, more delicate hinge, and nearly obsolete lunule. An obscure radial impression, which was at first taken to be pathological, extends on the fossil towards the anterior base. The recent forms show faint traces of a similar sulcation. In them the anterior dorsal area is not visibly delimited and the crenulation of the margins is more feeble.

Phacoides (**Here**) sp. indet.

Oligocene of the Oak Grove sands, Santa Rosa County, Florida; Burns.

A single immature valve of what appears to be a species of *Phacoides* different from any of which adults have been described was found with the other Oak Grove fossils. The shell is rather longer than high, with the nepionic portion of the beak closely concentrically ribbed but the rest nearly smooth; the anterior dorsal area is small, limited by a rather obscure, shallow, but narrow sulcus; the posterior area is set off by a broad, well-marked sulcus; the lunule is deep and wide, forming an excavation which intrudes across the hinge-line between the anterior lateral and the cardinals. All the teeth are well developed. Alt. 4.0, lon. 4.5, diam. (double) 2.0 mm.

The sculpture alters so with growth that I think it best not to name this species until more material comes to hand.

Phacoides (**Here**) **Richthofeni** Gabb.

Lucina (*Here*) *Richthofeni* Gabb, Pal. Cal., ii., p. 29, pl. viii., figs. 49 a–b, 1866.

Lucina excavata Carpenter, Mazatlan Cat., p. 98, 1857; not of Orbigny, 1851.

Phacoides (*Here*) *Richthofeni* Dall, Synopsis Lucinacea, Proc. U. S. Nat. Mus., xxiii., pp. 810, 827, pl. xl., figs. 7, 9, 1901.

Pliocene of San Quentin Bay, Lower California, Orcutt; living from Catalina Island, California, south to the Gulf of California.

This species is the type of the subgenus and has a very variable but occasionally very capacious excavated lunule, which, contrary to the rule in *P. Glenni,* increases in size with age.

Phacoides (**Here**) **densatus** Conrad.

Lucina densata Conrad, Am. Journ. Conch., iii., p. 13, 1867.

Lucina pennsylvanica Tuomey and Holmes, Pleioc. Fos. S. Car., p. 56, pl. xviii., fig. 3, 1856; not of Linnæus, Syst. Nat., ed. x., p. 688, 1758.

Oligocene of the Oak Grove sands, Santa Rosa County, Florida; Miocene

of the Natural Well and Magnolia, Duplin County, North Carolina, and of the Darlington district, South Carolina.

This form seems to be properly separated from the *P. pensylvanicus* L., for the reasons assigned by Conrad.

Phacoides (Here) pensylvanicus Linné.

Venus pensylvanica Linné, Syst. Nat., ed. x., p. 688, 1758; not of Tuomey and Holmes, 1856.

Lucina pennsylvanica Reeve, Conch. Icon., vi., Mon. *Lucina*, pl. vi., fig. 29, 1850.

Lucina grandinata Reeve, Conch. Icon., vi., Mon. *Lucina*, pl. vi., fig. 29 (note), 1850.

Lucina speciosa Reeve, *op. cit.*, pl. vi., fig. 32, 1850; not of Rogers, Trans. Am. Phil. Soc., 1836.

Pliocene marls of the Caloosahatchie, Shell Creek, and Alligator Creek, in south Florida; Pleistocene of Barbados (Damon) and other localities in the West Indian region; living from Cape Hatteras, North Carolina, southward throughout the West Indies and adjacent shores.

This well-known species does not appear in its typical form to antedate the Pliocene in a fossil state.

Section *Pleurolucina* Dall.

Phacoides (Pleurolucina) quadricostatus n. sp.

Plate 50, Figure 7.

Oligocene marl of Bowden, Jamaica; Henderson and Simpson.

Shell small, plump, oblique, high, short, with strongly impressed large dorsal areas; beaks small, prosogyrate, overhanging a very small cavernous lunule; ligament short; surface densely covered with high, concentric lamellæ with slightly wider interspaces, the distal edges of the lamellæ wider and reflexed dorsally; radial sculpture of four rapidly distally widening broad ribs separated by narrow sulci, the two inner ribs wider than the outer pair; hinge normal, strong; scars normal; inner margins of the valves crenate. Alt. 9, lon. 6, diam. 7 mm.

This is doubtless the precursor of the following species and of the recent *P. leucocyma* Dall.

Phacoides (Pleurolucina) amabilis Dall.

Plate 25, Figures 9, 9a.

Lucina (Here) amabilis Dall, Trans. Wagner Inst., iii., p. 920, pl. xxv., figs. 9, 9 a, 1898.

Pliocene marls of the Caloosahatchie and Shell Creek; Dall and Burns.

Shell solid, high, short, laterally very convex, longitudinally subcompressed, with large, moderately impressed, cordiform dorsal areas; beaks small, narrow, prosogyrate, with a small, globular, deeply excavated lunule, much larger proportionately and more open in the young shell; ligament very short; surface with little raised, flattish, concentric threads closely adjacent and with only linear interspaces; radial sculpture of four broad ribs separated by narrow, shallow sulci, which become obsolete towards the base, and an impressed line bordering the escutcheon; the middle pair of ribs occupy about one-third of the disk; hinge strong, teeth conical, normal; scars normal, inner margin of the valves entire, except some very minute crenulations near the middle of the base. Alt. 16.5, lon. 11.0, diam. 15.0 mm.

This is one of the most elegant species of the genus. The young, in which the lunule is apparently much larger and more open, at first would be taken for a distinct species.

Section *Cavilucina* Fischer.

The Eocene species of this section have been already enumerated.

Phacoides (Cavilucina) recurrens n. sp.

Plate 52, Figure 11.

Oligocene of the Bowden marls, Jamaica; of the Chipola beds on the Chipola River, and the lower bed at Alum Bluff on the Chattahoochee River, and the silex beds at Miami, Florida.

Shell small, flattish or only moderately convex, oblique, inequilateral, the dorsal areas hardly indicated; beaks small, low, prosogyrate over a small, moderately impressed, rather narrow lunule; posterior dorsal margin convexly arched, as high as the beaks; surface finely, concentrically, rather closely grooved, with, towards the base, two or three deep, concentric sulci indicating resting stages; hinge-teeth small but distinct; inner margins of the valves minutely crenulate. Alt. 6.5, lon. 5.7, diam. 4.0 mm.

This little species is more like the recent West Indian *P. blandus* Dall than the intervening colder water Miocene forms.

Phacoides (Cavilucina) trisulcatus Conrad.

Lucina trisulcata Conrad, Trans. Am. Assoc. Nat. and Geol., i., p. 110, 1841; Am. Journ. Sci., xli., p. 346, 1841; Fos. Medial Tert., p. 71, pl. xl., fig. 5, 1845; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 62, pl. xviii., figs. 18, 19, 1857; Holmes, Post-Pl. Fos. S. Car., p. 28, pl. vi., fig. 4, 1860; Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p.

577, 1863; Meek, S. I. Checkl. Mioc. Fos., p. 8, 1865; Heilprin, Proc. Acad. Nat. Sci. Phila. for 1887, pp. 400, 403.

Lucina multistriata Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 307, 1843; Fos. Medial Tert., p. 71, pl. xl., fig. 6, 1845.

Codakia multistriata Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 577, 1863.

?Lucina trisulcata Whitfield, Mioc. Moll. N. Jersey, p. 64, pl. x., figs. 1–4, 1895; Mon. U. S. Geol. Survey No. xxiv.

Upper Oligocene to the Pliocene; recent?

P. trisulcatus variety **Whitfieldi** Dall.

Upper Oligocene of the Oak Grove sands at Oak Grove, Santa Rosa County, Florida, and lower Miocene of the artesian well at Atlantic City, Whitfield; Pliocene of the Waccamaw district, South Carolina, Johnson.

P. trisulcatus variety **trisulcatus** Conrad.

Miocene of the Natural Well and Magnolia, Duplin County, North Carolina, Conrad and Burns; Pliocene of the Caloosahatchie and Shell Creek; recent?

P. trisulcatus variety **multistriatus** Conrad.

Miocene of Wilmington, North Carolina, Conrad, and of the Duplin Natural Well, Burns.

The first variety is broader, rather flatter, larger, and with fewer resting stages and stouter hinge. The second has more pronounced and numerous resting stages, the sculpture between them being rounded over like broad concentric ribs, the shell being smaller, narrower, and with more pointed beaks. Variety *multistriatus* has feeble and obsolete radial striation and the general form of variety *Whitfieldi*. The first has been figured by Whitfield, the others by Conrad and others.

Were the characters of these shells at all constant they would properly be regarded as species, but they appear to vary exceedingly, and analogous variations, quite as marked, may be observed in a sufficiently extended geographical series of the recent shell which goes under Conrad's name. I confess that I am unable to separate the various forms from each other specifically, and feel obliged to regard them as mutations of an extremely variable polymorphic species. The variety *multistriatus* is not *Lucina multilineata* of Tuomey and Holmes, as stated by Conrad in the "Proceedings of the Academy of Natural Sciences for 1862," p. 577, the latter being a *Parvilucina*.

Subgenus LUCINISCA Dall.

Phacoides (Lucinisca) calhounensis n. sp.

PLATE 52, FIGURE 16.

Oligocene of the silex beds at Ballast Point, Tampa Bay, Florida, and of the Chipola beds at the Chipola River, Calhoun County, Florida; Dall and Burns.

Shell resembling *P. cribrarius* Say in its general features, but with the sculpture more dense, the reticulation finer and more even, the radial ribs being of about the same strength and prominence as the concentric ridges, except near the umbones; the umbonal concentric ridges are less distant and prominent and those close to the beaks are heavier and broader relatively to the size of the shell, the anterior dorsal area is more conspicuous, the lunule proportionately longer and larger, the crenulations of the inner margins of the valves finer and more numerous. Alt. 10.0, lon. 10.0, diam. 4.5 mm.

This is in every way a smaller, finer, and more delicate shell than *P. cribrarius*. The silicious pseudomorphs from Ballast Point appear to have lost nearly all their prominent sculpture and were probably consequent upon the fossilization of worn, dead valves, which have a very different aspect from the perfect shell.

Phacoides (Lucinisca) plesiolophus Dall.

PLATE 40, FIGURES 2, 5.

Lucina plesiolopha Dall, Trans. Wagner Inst., iii., p. 1196, pl. xl., figs. 2, 5, 1900.

Upper Oligocene of the Oak Grove sands, Santa Rosa County, Florida; Burns.

Shell thin, suborbicular, compressed, with high, pointed, prosogyrate beaks and conspicuous dorsal areas; concentric sculpture of low, rather strong, moderately elevated ribs, tending to become obsolete towards the base and on the anterior third of the disk; they are also rather distant, more so than in any of the other Tertiary species of this group; radial sculpture of rather close-set, rounded, low, even threads increasing by intercalation rather than divarication, and stronger towards the ends of the valve; the posterior dorsal area is bounded in front by a rather strong radial rib; on this the concentric ridges rise into little, triangular leaflets, and similarly but less conspicuously on the posterior dorsal margin; there is a wider shallow sulcus on each side of this rib; the anterior dorsal area is very small and narrow with one or two radials upon it; the lunule is lanceolate, small, and emphatically excavated, larger in the left

than in the right valve; hinge normal, the internal margins of the valve finely crenulate. Alt. 15.5, lon. 5.5 mm.

This is the largest and most feebly sculptured of the east American Tertiary species of this group.

Phacoides (Lucinisca) cribrarius Say.

Lucina cribraria Say, Journ. Acad. Nat. Sci. Phila., iv., p. 147, pl. xiii., fig. 1, 1824; Conrad, Bull. Nat. Inst., ii., p. 187, 1842; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 58, pl. xviii., figs. 8, 9, 1857; Emmons, Geol. N. Car., p. 293, fig. 218, 1858.

Codakia cribraria Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 577, 1863.

Miocene of St. Mary's, Maryland, Conrad and Finch; of Prince George County, Yorktown and Petersburg, Virginia, Harris and Burns; of Magnolia, Duplin County, North Carolina; Darlington, South Carolina; of the upper bed at Alum Bluff, Chattahoochee River, and of the Ocklockonnee River, Florida. The typical locality is in St. Mary's County, Maryland.

The newer Miocene, as in North and South Carolina and Florida, contains specimens nearly intermediate between the typical *cribrarius* and the *muricatus* Spengler.

The type form of this species has no produced ornamentation about the posterior dorsal area, and the radial sculpture and marginal crenulation are markedly coarser than in the recent species.

Phacoides (Lucinisca) nassula Conrad.

Lucina nassula Conrad, Am. Journ. Sci., ii., p. 394, 1846; Proc. Acad. Nat. Sci. Phila., iii., p. 24, 1846; Dall, Bull. U. S. Geol. Survey No. 24, p. 149, 1885; Bush, Trans. Conn. Acad. Sci., vi., p. 478, 1885.

Lucina lintea Conrad, Am. Journ. Conch., ii., p. 281, pl. xv., fig. 7, 1866; Dall, Bull. U. S. Nat. Mus. No. 37, p. 52, 1889.

Pleistocene of North Creek, near Osprey, West Florida, Dall; recent from near Cape Hatteras, North Carolina, south to Cuba and west to Mobile Bay.

Phacoides nassula variety **caloosana** Dall.

Pliocene of the Caloosahatchie beds in south Florida, on the Caloosahatchie and Shell Creek; Dall and Burns.

This form differs from the Pleistocene and recent shell by being shorter, higher, and longer when fully grown, in having the concentric sculpture sharper and more prominent above the radials; the lunule averages larger and the den-

ticulations of the margin coarser than in the *P. nassula.* It is, of course, the immediate precursor and progenitor of the later form.

Phacoides (Lucinisca) Nuttallii Conrad.

Lucina Nuttallii Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 255, pl. xx., fig. 2, 1837.

Phacoides (Lucinisca) Nuttallii Dall, Synopsis Lucinacea, Proc. U. S. Nat. Mus., xxiii., p. 813, 1901.

Pleistocene of San Diego, California, Dall and Stearns; recent from Santa Barbara to the Gulf of California.

This fine species is larger than any of the others mentioned, and in the group to which it belongs is only surpassed by *P. fenestratus* Hinds of west Mexico, which has not yet been reported in the fossil state.

Phacoides (Lucinisca) muricatus Spengler.

Tellina muricata Spengler, Skrift. Naturf. Selsk., iv., pt. ii., p. 120, No. 62, 1798; Chemnitz, Conch. Cab., xi., p. 209, pl. cxcix., figs. 1945–6, 1799?; Wood, Gen. Conch., p. 185, 1815; Dillwyn, Cat. Rec. Sh., i., p. 98, 1817 (La Guayra).

Tellina imbricata Chemnitz, Conch. Cab., xi., p. 207, 1799? (name only).

Lucina scabra Lam., An. s. Vert., v., p. 542, 1818 (after Enc. Méth., Vers., ii., pl. cclxxxv., figs. 5 a–c); Fischer, Journ. de Conchyl., iv., p. 414, 1853; Reeve, Conch. Icon., *Lucina,* pl. viii., fig. 45, 1850.

Lucina scobinata Récluz, Journ. de Conchyl., iii., p. 252, pl. x., figs. 6, 6′, 1852; Tryon, Proc. Acad. Nat. Sci. Phila. for 1872, p. 87.

Not *Tellina scabra* Chemnitz, *op. cit.,* p. 207; Dillwyn, *op. cit.,* p. 96; Gray, Ann. Phil., 1825, p. 136; or Wood, Ind. Test., pl. iv., fig. 72, 1828; = *Lucina jamaicensis* Lamarck.

Although the title-page of the volume of the "Conchylien Cabinet" in which Chemnitz cites Spengler's description is dated 1795, the work cited appeared in 1798; consequently Tryon's reference of this part of volume xi. of Chemnitz's work to the year 1799 seems justified. On the page where Chemnitz gives a list of the species of *Tellina* about to be described the denomination of this species is *T. imbricata* and not *muricata,* which may be the name Chemnitz had intended to apply before consulting Spengler's work, or perhaps is merely an error.

The recent form extends from the Florida Keys throughout the West Indies and the adjacent waters. It is stated by Guppy to be found in the fossil state in the Pliocene of Trinidad, West Indies, and in the Pleistocene of Barbados, but I have not been able to compare any specimens with the recent shell. It is easily distinguished from any other species of the group by its profusely spinose radial ribs with very inconspicuous concentric sculpture.

Subgenus MILTHA H. and A. Adams.

This group is very abundant in the Eocene Tertiaries, dwindling until it is represented in existing faunas, so far as known, only by two living species, one in the Gulf of California and one in the Indian Ocean.

The typical section comprises species in which the cardinal teeth are clear-cut and well developed. It, again, comprises three groups of species represented in most horizons down to the Pliocene and two of which are known to survive. These are:

A. Species of which the surface sculpture is characterized by concentric lamellation like *P.* (*M.*) *disciformis* and *hillsboroënsis* of Heilprin.

B. Species compressed, high, and with fine concentric striation, like *P.* (*M.*) *Childreni* Gray and *caloosaënsis* Dall.

C. Species with sculpture similar to the last but more convex and elongated and with a somewhat sinuous basal profile, like *P.* (*M.*) *pandatus* Conrad and *Voorhoevii* Deshayes.

Phacoides (Miltha) claibornensis Conrad.

Plate 50, Figure 18.

Cyclas claibornensis Conrad, Am. Journ. Conch., i., pp. 8, 146, 1865.

Lucina claibornensis Aldrich, Geol. Surv. Ala., Bull. No. ii., p. 57, 1886 (Gregg's Landing); Meyer, Bericht Senckenb. Naturf. Ges., 1886, p. 16, 1887 (Jackson, Miss.); Gregorio, Mon. Claiborne, p. 204, 1890.

?Lucina amica Gregorio, Cossmann, Notes Compl., p. 12, 1894.

Eocene of Lisbon Bluff, and of the lowest bed at Claiborne Bluff, Alabama, the Aquia formation at Pope's Creek, Maryland, and of Jacksonian of Garland's, Clarke County, Mississippi (a variety?), and Jackson, Mississippi.

A figure of this hitherto unfigured species is given, as in the absence of one it can hardly be identified. It belongs to group A. of the section. The form from the Jacksonian is apparently wider and with shorter and more prominent dorsal areas, but I have not sufficient material to be able to positively differentiate it from that of the Lisbon horizon.

Phacoides (Miltha) pandatus Conrad.

Lucina pandata Conrad, Am. Journ. Sci., xxiii., p. 343, Jan., 1833; Fos. Tert. Form., No. 4, p. 40, Oct., 1833; Orbigny, Prodr. Pal., p. 387, 1850.

Lucina compressa Lea, Contr. Geol., p. 55, pl. i., fig. 27, Dec., 1833; Aldrich, Geol. Surv. Ala., Bull. No. 2, pp. 9, 37, 1886; Gregorio, Mon. Claib., p. 206, pl. xxix., figs. 1, 2–5, 1890.

Cyclas pandata Conrad, Am. Journ. Conch., i., p. 8, 1865.
Lucina (Miltha) compressa Cossmann, Notes Compl., p. 11, 1894.

Eocene of Lisbon Bluff, of the Claiborne sands at Claiborne Bluff, and in Jackson County, Alabama, and near Meridian, Mississippi.

Lucina claytonia Harris, from the Chickasawan Eocene, is also a Miltha belonging to group B. of the section.

Phacoides (Miltha) ocalanus n. sp.

PLATE 50, FIGURE 14.

Oligocene of the Ocala horizon, Ocala, south Florida; Willcox.

Specimens found in the form of internal casts only; valves elongated, with low, subcentral beaks, the interior of the disk radially finely striated, anterior and posterior adductor scars very long and narrow, rather oblique; posterior end of the shell almost rostrate. Alt. 33, lon. 41, diam. 12 mm.

This species is of the *pandatus* type, but that species has a rounded, not elongate, posterior adductor scar, is not oblique, and is more compressed. No species of *Miltha* has been listed from the Vicksburgian, of which the Ocala beds form the upper culmination, and therefore I feel justified in applying a name to these specimens. A cast of similar character but less well preserved was collected from the Vicksburgian of Padlock, Florida, by the United States Geological Survey.

Phacoides (Miltha) chipolanus n. sp.

PLATE 51, FIGURE 11.

Oligocene of the Chipola River, Florida; of the lower bed at Alum Bluff, Chattahoochee River, Florida, and of Hawkinsville, Georgia; Dall and Burns.

Shell large, rather thin, compressed, with small, pointed, recurved beaks, over a small, narrow, rather deeply impressed lunule; there is no anterior dorsal area; the posterior area is long, narrow, and divided into two nearly equal parts by an impressed line; sculpture of fine, slightly irregular concentric raised threads, stronger distally, sublamellose on the dorsal area, fainter in the middle of the disk, and rather close-set; radial sculpture of faint, obscure, slightly vermicular markings, hardly visible except in the middle of the disk; anterior adductor scar elongate; posterior short, ovate; cardinal teeth well developed; ligament short, deeply inset. Alt. 75, lon. 71, diam. about 11 mm.

The figure of this species is restored from a number of fragments which give practically all the characters except the hinge of the left valve. It is a large, very compressed form belonging in group B.

Phacoides (Miltha) heracleus n. sp.

PLATE 51, FIGURE 10.

Oligocene of the lower bed at Alum Bluff, and at Ballast Point, Tampa Bay, Florida; Dall and Burns.

Shell large, convex, subequilateral, rather thick, with small, pointed, prosogyrate beaks over an arcuately impressed, small, sublanceolate lunule; anterior dorsal area narrow and rather short, defined by a shallow sulcus; posterior area narrow elongate, divided by a second longitudinal sulcus into two parts, of which the anterior is wider; sculpture of fine concentric lines, feebler in the middle of the disk, and of faint, nearly obsolete, sparser radial striations; ligament deeply inset, rather long; cardinals normal, rather small and slender. Alt. 80, lat. 77, diam. 30 mm.

This large species recalls the *Pseudomiltha gigantea* of the Parisian Eocene, but the teeth are developed. Only one right valve and a fragment have so far been obtained.

Phacoides (Miltha) hillsboroënsis Heilprin.

Lucina hillsboroënsis Heilprin, Trans. Wagner Inst., i., pp. 117, 120, pl. xvi., fig. 62, 1886.

Chipola beds at Alum Bluff and on the Chipola River, Calhoun County, Florida, and at Ballast Point, Tampa Bay, in the silex beds; Burns, Heilprin, and Dall.

This fine species is notable for its rather irregular concentric lamellation with the interspaces finely concentrically striated. The teeth are well developed, the lunule quite narrow and deep. The specimens from the marl are generally deprived of the outer coat, thus removing all the lamellation, and exhibit a faint radial striation which makes them hardly recognizable as the same species as a complete specimen. The quite young shell is thin, convex, more transverse, and has the aspect of a young *Lucina*.

Phacoides (Miltha) caloosaënsis Dall.

PLATE 28, FIGURE 1.

Lucina (Miltha) caloosaënsis, Trans. Wagner Inst., iii., p. 923, pl. xxviii., fig. 1, 1898.

Pliocene of the Caloosahatchie and Shell Creek, Florida; Willcox, Dall, and Burns.

Shell elevated, rather compressed, short, finely concentrically striated; beaks small, pointed, slightly curved forward over an extremely minute and almost obsolete lunule; anterior dorsal area short, narrow, feebly defined; posterior area long, wider, defined by a narrow sulcus, with a less pronounced sulcation

dividing the area lengthwise into nearly equal parts; there are traces of very minute radial striation on some specimens; resilium shorter than the ligament, both deeply inset and partly covered by the dorsal margin, which is usually broken away; teeth and scars normal, well developed; disk internally with a well-marked oblique sulcus. Alt. 53.0 (to 63.0), lon. 47.0, diam. 13.5 mm.

The lunule is better developed in the older specimens and more in the right than in the left valve. Some specimens have the right valve less convex than the left. The species is very like *P.* (*Miltha*) *Childreni* Gray, but is proportionally more elevated, with a more delicate hinge and smaller muscular impressions. In the Pacific species, when there is a perceptible difference in the convexity of the valves, it is the left one which is flatter, and it is a curious coincidence that similar differences occur between the Atlantic and Pacific species of *Tellidora,* also inequivalve shells.

Phacoides (Miltha) Childreni Gray.

Tellina Childreni Gray, Ann. Phil., xxv., p. 136, 1824; Zool. Journ., i., p. 221, 1825.
Lucina Childreni Gray, Sowerby, Gen. Shells, No. 27, *Lucina,* fig. 3, 1826; Reeve, Conch. Icon., vi., *Lucina,* pl. iii., fig. 12, 1850.
Miltha Childreni H. and A. Adams, Gen. Rec. Moll., ii., p. 468, 1857.

Pliocene of San Juan, Gulf of California, Orcutt; living in the Gulf of California.

This is the type of the subgenus and one of the two known living species, the other being a native of Mozambique.

Phacoides (Miltha) disciformis Heilprin.

Lucina disciformis Heilprin, Trans. Wagner Inst., i., pp. 94, 103, pl. xii., fig. 28, 1886.

Pliocene of the Caloosahatchie and Shell Creek, Florida; Willcox and Dall.

This is one of the species of group A, with strong concentric lamellation, recalling *Lucinoma;* it is close to *P. hillsboroënsis* Heilprin, of the Oligocene, but has longer and less marked dorsal areas and grows to a larger size. Besides their superficial characters the shells of this group are notable for the deep bifurcation of the major cardinal tooth, which appears like two separate teeth, and for the small size of the posterior and extreme narrowness of the anterior adductor scars. The lunule is small, narrow, deep, and somewhat ill-defined. The internal punctation of the disk is often coarse and strong.

A curious species described by Gabb from the Cretaceous of California under the name of *Dosinia* (later *Lucina*) *gyrata* (Pal. Cal., i., p. 168, pl. xxiii., fig. 148, 1865) is probably a species of *Miltha.*

The *Lucina subobliqua* Say (Journ. Acad. Nat. Sci. Phila., iv., p. 147, 1824) is still unfigured and I have not seen specimens. It would appear to be a *Miltha* from the description, though only four-fifths of an inch in length, and was obtained from the Miocene of Maryland, probably in St. Mary's County.

Phacoides (Pseudomiltha) anodonta Say.

Lucina anodonta Say, Journ. Acad. Nat. Sci. Phila., iv., p. 146, pl. x., fig. 9, 1824; Conrad, Fos. Medial Tert., p. 40, pl. xx., fig. 4, 1840; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 55, pl. xviii., fig. 2, 1857; Emmons, Geol. N. Car., p. 291, 1858.

Miocene of Maryland near Easton and on the Patuxent River, the St. Mary's River, the Choptank at Barker's Landing, Blake's Cliffs, Skipton, Jones Wharf, Plum Point, Calvert Cliffs, and in St. George County; of Virginia at City Point and Grove Wharf on the James River, Urbana, Petersburg, and the York River; of North Carolina at Wilmington; Pliocene of the Waccamaw district, South Carolina, and of the Caloosahatchie, Shell Creek, and Alligator Creek, Florida.

This widely distributed species, notwithstanding a certain amount of variability, is easily identified and its heavy shell, more or less irregularly externally wrinkled, and obsolete hinge-teeth are conspicuous characters.

The *Lucina undula* Conrad (Fos. Medial Tert., p. 71, pl. xli., fig. 1, 1845) from its effaced hinge would appear to belong in this vicinity, and the type may have been an abnormal *P. anodonta*. It came from Craven County, North Carolina, on the Neuse River, and the figure looks not unlike some specimens of *P. Foremani*.

Phacoides (Pseudomiltha) Foremani Conrad.

Lucina Foremani Conrad, Journ. Acad. Nat. Sci. Phila., viii., p. 184, 1842; Proc. Acad. Nat. Sci. Phila., i., p. 29, 1843; Fos. Medial Tert., p. 71, pl. xl., fig. 4, 1845; Emmons, Geol. Rep. N. Car., p. 291, fig. 217, 1858; Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 577, 1863.

Miocene of Maryland at Calvert Cliffs, Blake Cliffs, and Plum Point; Burns and Harris.

A rude, rather convex and rotund species, distinguished from *P. anodonta* by its smaller size, more convex and rounded shell, and usually by its sharper concentric sculpture.

Phacoides (Pseudomiltha) floridanus Conrad.

Lucina floridana Conrad, Am. Journ. Sci., xxiii., p. 344, 1833; ?Heilprin, Trans. Wagner Inst., i., pp. 102–3, 1886; Harris, Bull. Am. Pal., i., p. 90, 1895.

Loripes floridana Tryon, Proc. Acad. Nat. Sci. Phila. for 1872, p. 89.

Upper Miocene of the artesian well at Galveston, Texas, at a depth of from 2236 to 2871 feet below the surface, *fide* Harris; Pliocene of the Caloosahatchie beds, *fide* Heilprin; living on the shores of the Gulf of Mexico from Charlotte Harbor, Florida, to Corpus Christi, Texas.

The specimens of this species from the Galveston well were fragmentary; those from the Caloosahatchie marl have much larger adductor scars than the recent *P. floridanus* of the same size, and I am disposed to regard them as young specimens of *P. anodonta*. I have seen no fossil specimens which I feel confident are identical with the living shell, but I have included it here on account of the above-mentioned identifications.

Phacoides (Lucinoma) acutilineatus Conrad.

Lucina acutilineata Conrad, Wilkes' Expl. Exp. Report, vol. x., Geology, App., p. 725, pl. xviii., figs. 2a, 2b, 1849; Gabb, Pal. Cal., ii., p. 100 (*ex parte*); Conrad, Am. Journ. Conch., i., p. 153, 1865.

(Oligocene or) Miocene of the Astoria shales at Astoria, Oregon, Wilkes; Empire beds (Miocene) of Coos Bay, Oregon, Dall.

All the specimens of this species, especially Conrad's types in the National Museum, are in poor condition. They differ from the recent forms which have been by Carpenter, Cooper, and Gabb referred to this species by being much heavier and thicker shells with the concentric lamellæ heavier and more like ribs. They are more convex than the recent *P. annulatus* Reeve, and have the beaks higher and more central.

Phacoides (Lucinoma) annulatus Reeve.

Lucina annulata Reeve, Conch. Icon., vi., *Lucina*, pl. iv., fig. 17, 1850.

Lucina acutilirata Cooper (as of Conrad) in Carpenter, Rep. Brit. Assoc. Adv. Sci. for 1863, p. 97, 1864.

Lucina borealis Carpenter, not of Linnæus.

Phacoides (Lucinoma) annulatus Dall, Synops. Lucinacea, Proc. U. S. Nat. Mus., p. 813, pl. xl., fig. 10, 1901.

Pliocene of San Quentin Bay, Lower California, Orcutt; living from Sitka, Alaska, to San Pedro, California, in eight to one hundred and thirty-five fathoms, Dall.

This species is more delicate, more inequilateral, less solid and convex, and with much more delicate concentric sculpture than *P. acutilineatus*, with which it has frequently been confused.

The *Lucina fibrosa* Shumard (Trans. St. Louis Acad. Sci., i., p. 120, 1860)

from the Oligocene lignitiferous shales of Coos Bay, Oregon, is still unfigured, and in the absence of typical specimens can hardly be recognized, but appears from the description to belong in this section. *L. permacra* Conrad (Pacific R. R. Rep., vii., part i., p. 192, pl. vii., fig. 4, 1857) and *L. tetrica* Conrad (Proc. Acad. Nat. Sci. Phila., viii., p. 314, 1856, unfigured) are from the Miocene of California, very likely are synonyms of *P. acutilineatus* Conrad, but in the absence of types, figures, or sufficient descriptions may be dismissed as unrecognizable, though not improbably belonging in this section.

Phacoides (Lucinoma) contractus Say.

Lucina contracta Say, Journ. Acad. Nat. Sci. Phila., iv., pp. 145–6, pl. x., fig. 8, 1824; Conrad, Fos. Medial Tert., p. 40, pl. xx., fig. 5, 1840; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 54, pl. xviii., fig. 1, 1857.

Lucina subplanata Conrad, Journ. Acad. Nat. Sci. Phila., viii., p. 184, 1841; Proc. Acad. Nat. Sci. Phila., i., p. 29, 1841; Bull. Nat. Inst., ii., p. 181, 1842.

Lucina subplana Meek, Checkl. Miocene Fos., p. 8, 1864 (err. pro *subplanata*).

Miocene of Maryland at Calvert Cliffs, Plum Point, and in Charles County; of the eastern shore of Virginia and at Suffolk, Virginia; of the Ashley River beds of South Carolina, and of Florida at Alum Bluff on the Chattahoochee River; Burns. The variety *subplanatus* at Plum Point and Calvert Cliffs, Maryland; Harris.

This is very near to but differs sufficiently from the recent *P. filosus* Stimpson, of the Atlantic coast fauna; but from the recent and Pliocene Pacific coast form, *P. annulatus* Reeve, it can hardly be separated. The *P. subplanatus* is only a local mutation with closer and more delicate sculpture, and hardly deserves a varietal name.

Phacoides (Callucina) pauperatus Guppy.

Lucina pauperata Guppy, Proc. U. S. Nat. Mus., xix., p. 326, pl. xxx., fig. 8, 1896.

Oligocene of the marl at Bowden, Jamaica; Vendryes, Bland, and Henderson.

A small species, the evident precursor of *P. radians* Conrad.

Phacoides (Callucina) radians Conrad.

Lucina radians Conrad, Trans. Am. Assoc. Nat. and Geol., i., p. 110, 1840; Am. Journ. Sci., xli., p. 347, 1841; Emmons, Geol. Rep. N. Car., p. 291, 1858; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 57, pl. xviii., figs. 4, 5, 1857; Holmes, P.-Pl. Fos. S. Car., p. 28, pl. vi., fig. 3, 1860.

Lucina radiata Conrad, Fos. Medial Tert., p. 70, pl. xl., fig. 3, 1845; not of Deshayes, 1843.

Phacoides (*Lucinoma*) *radians* Dall, Synops. Lucinacea, pp. 809, 824, pl. xlii., fig. 8, 1901.

Upper Miocene of North Carolina at Magnolia and the Natural Well, Duplin County, and at Wilmington; of South Carolina in the Darlington district; Pliocene of the Neuse River, below New Berne, North Carolina, of the Waccamaw district, South Carolina, and of Shell Creek, Florida. Living from North Carolina, south to Florida and Porto Rico, in five to eighty-five fathoms.

A well-characterized and elegant species which has not changed appreciably since the Miocene.

Phacoides (Epilucina) sp. indet.

A fossil from Mt. Enterprise, Texas, has been referred to this group, but in the absence of any knowledge of the hinge or interior, which is filled with hard rock, I think it inadvisable to describe it at present.

Phacoides (Epilucina) californicus Conrad.

Lucina californica Conrad, Journ. Acad. Nat. Sci., vii., p. 255, pl. xx., fig. 1, 1837.

Lucina artemidis Carpenter, P. Z. S., 1856, p. 201, No. 22.

Phacoides (*Epilucina*) *californicus* Dall, Synops. Lucinacea, p. 813, 1901.

Pleistocene of Santa Barbara and San Pedro, California; living from Crescent City to San Diego, California, in three to fifteen fathoms.

A remarkable species, unique among recent forms.

Phacoides (Parvilucina) Smithi O. Meyer.

Lucina Smithi O. Meyer, Bull. Ala. Geol. Survey, i., p. 81, pl. i., fig. 23, 1886.

?Lucina impressa Cossmann, Notes Compl., p. 12, 1894.

Lucina Whitei Clark, Johns Hopkins Univ. Circ., xv., p. 5, 1895; Bull. 141 U. S. Geol. Survey, p. 79, pl. xx., figs. 3a–3c, 1896; Maryland Geol. Surv., Eoc. Deposits, p. 176, pl. xxxvii., figs. 8, 8a, 9, 1901.

Eocene of Wood's Bluff, Choctaw Corners, and Claiborne, Alabama; of Meridian, the Wahtubbee Hills, Garland's Creek, and Jackson, Mississippi; of Montgomery, Louisiana; and of the Nanjemoy formation, Woodstock, Maryland.

This is the Eocene representative of the *Parvilucina* group, but I am unable, in the rather abundant material at my disposal, to distinguish more than one specific form. It is considerably larger than *P. yaquensis* when adult.

Phacoides (Parvilucina) yaquensis Gabb.

Lucina yaquensis Gabb, Geol. of St. Domingo, p. 251, 1873.

Oligocene of St. Domingo and of the marl at Bowden, Jamaica; Henderson and Simpson.

This species differs from the Chipolan form, *P. sphæriolus,* in being much more delicate, rather smaller, with almost obsolete radial sculpture, much smaller lunule, and stronger, more rounded, and close-set concentric sculpture; the largest valve is about four millimetres in length.

Phacoides (Parvilucina) sphæriolus n. sp.

Plate 52, Figure 15.

Chipola Oligocene of the Chipola River and of the lower bed at Alum Bluff, Chattahoochee River, Calhoun County, Florida; Dall and Burns.

Shell small, plump, rounded, subequilateral, with small, somewhat prosogyrate beaks; lunule small, lanceolate, moderately excavated; escutcheon linear or none; dorsal areas indicated by the absence of radial sculpture, hardly impressed; disk with twenty-four or more rounded radial riblets, of variable strength, but not bifurcate, crossed by rather sparse, thin, little elevated lamellæ which are higher on the dorsal areas; hinge normal, strong; inner margins strongly crenulate. Alt. 4.0, lon. 4.2, diam. 2.75 mm.

A larger and more solid shell with stronger radials, larger lunule, and less close and regular concentric sculpture than in *P. yaquensis.*

Phacoides (Parvilucina) piluliformis n. sp.

Plate 52, Figure 6.

Upper Oligocene of Walton County, De Land, and Oak Grove, Santa Rosa County, Florida; Miocene of the artesian well at Galveston, Texas, at a depth of 2552 to 2600 feet below the surface(?).

Shell small, plump, rounded, with small inconspicuous beaks; lunule lanceolate, small, impressed and clearly delimited; escutcheon narrow, depressed, elongated, bordered by a sharply angular keel; dorsal areas large, distinctly impressed, sinuating the margin; radial sculpture faint or obsolete; concentric sculpture irregular, like strong incremental lines, tending to become lamellose over the dorsal areas; hinge strong, marginal crenulation rather fine. Alt. 4.0, lon. 4.5, diam. 4.0 mm.

A convex little shell with almost exactly the sculpture of the recent *P. tenuisculptus* Cpr.

Phacoides (Parvilucina) crenulatus Conrad.

PLATE 52, FIGURE 12.

Lucina crenulata Conrad, in Morton, Synops. Org. Rem., App., p. 2, 1834; Journ. Acad. Nat. Sci. Phila., vii., p. 125, 1834; nude names.

Lucina crenulata Conrad, Fos. Medial Tert., p. 39, pl. xix. (2d ed.), fig. 8; pl. xx., fig. 2, May, 1840; Bull. Nat. Inst., No. ii., p. 181, 1842; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 60, pl. xviii., figs. 14–15, 1857; Emmons, Geol. Rep. N. Car., p. 291, fig. 217, 1858; Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 577, 1863; Gabb, Geol. St. Domingo, p. 251, 1873; Whitfield, Mio. Moll. N. J., p. 63, pl. x., figs. 7–15, 1895; not of Searles Wood, 1850.

Lucina lens H. C. Lea, Trans. Am. Phil. Soc., 2d Ser., ix., p. 240, pl. xxxiv., fig. 19, 1845; not of Deshayes, 1843.

Lucina Leana Orbigny, Prodr. Pal., iii., p. 117, 1852; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 577, 1863.

Miocene (mixed with Oligocene) of Jericho, New Jersey; Miocene of Maryland at Plum Point, St. Mary's River, Calvert Cliffs, and Jones Wharf; of Virginia at Petersburg, Yorktown, other localities on the York River, and Suffolk (type locality); of North Carolina at Wilmington, and Magnolia and the Natural Well in Duplin County; of Florida, in the upper bed at Alum Bluff, Chattahoochee River.

The original locality of this species is at Suffolk, Virginia, where it is abundant. The Suffolk specimens have therefore been taken as a standard with which the material from other localities and horizons might be compared, and, as is natural, it has been found that some of the forms hitherto very generally regarded as or called by the name of *crenulatus* are sufficiently distinct to be specifically separated from the Suffolk fossil. The latter is a moderately convex, slightly inequilateral shell, rather solid, with inconspicuous, slightly prosogyrate beaks, moderately excavated lanceolate lunule, and dorsal areas indicated only by the absence of radial sculpture. The disk is sculptured by more or less distinct, low, close-set, radial threads which do not cancellate the concentric sculpture of numerous rather stout, low, flat-topped lamellæ, separated by slightly wider interspaces, and on the dorsal areas rather thinner and more elevated. The hinge is well developed and the inner margins are finely crenulated. The average adult dimensions are: Alt. 6.0, lon. 6.5, diam. 4.0 mm., but rare individuals attain a length of as much as 8.0 mm.

The specimens from Alum Bluff, Florida, form a variety which may be named *pemphigus* and which differs from the original type by its more convex and rounded form, stronger hinge, more prominent and close-set concentric

lamellation, distinctly impressed dorsal areas, and larger average size. Alt. 7.5, lon. 7.5, diam. 6.5 mm.

There is some variation due to age and some to variability of the individual, but on the whole the species is quite constant in all its features except the strength of the radial sculpture. Differences due to wear of the concentric lamellation are, of course, common and to be allowed for.

The shell enumerated in Mr. Searles Wood's Catalogue of Crag Fossils in the "Annals" for 1840, under the name of *Lucina crenulata,* but not described until later, belongs to the same group as the present species, but appears to me specifically distinct from it after a comparison of specimens.

Phacoides (Parvilucina) prunus n. sp.

Plate 52, Figure 8.

Miocene of Plum Point (abundant) and St. Mary's River, Maryland, and the James River, Virginia; Burns.

Shell resembling *P. crenulatus* but flatter, more inequilateral, with thicker and more regular concentric ribs, no radial sculpture, the inner margins more finely crenulate or even smooth, lunule shorter and wider, and the posterior dorsal area narrower and more vertical than in *P. crenulatus.* Alt. 6.5, lon. 7.0, diam. 4.0 mm.

The beaks are much more prominent and more recurved over the small globular lunule, the ribs are wider than their interspaces, and the radial structure is seen only when the shell is decorticated.

Phacoides (Parvilucina) multilineatus Tuomey and Holmes.

Lucina multilineata T. and H., Pleioc. Fos. S. Car., p. 61, pl. xviii., figs. 16, 17, 1857; Emmons, Geol. Rep. N. Car., p. 291, 1858; Holmes, Post-Pl. Fos. S. Car., p. 30, pl. vi., fig. 6, 1860.

?Phacoides (Parvilucina) crenella Dall, Synopsis Lucinacea, pp. 810, 825, pl. xxxix., fig. 2, 1901.

Pliocene of North Carolina at Croatan; Tilly's Lake, Waccamaw district, South Carolina; of the Caloosahatchie beds in Florida on the Caloosahatchie, Myakka, and Shell Creek; Pleistocene of Simmons Bluff, South Carolina, and North Creek, near Osprey, Florida.

This is a fine, plump little shell, in which the concentric sculpture is so reduced that it forms a feeble cancellation with the usually coarser but somewhat variable radial threads. The lunule is short and quite deeply impressed, and the marginal crenulations coarser than in *P. crenulatus.* The identity of the recent species with it is probable but not certain.

Phacoides (Parvilucina) intensus n. sp.

PLATE 50, FIGURE 8.

Pliocene of San Diego, California, from a depth of one hundred and sixty feet below the surface in the City Park well; Hemphill.

Shell small, resembling *P. tenuisculptus* Cpr., but with the concentric sculpture much sharper though very fine, the radials feeble, the lunule large, lanceolate, and impressed, the beaks small and prominent, the hinge very delicate, the posterior dorsal area with a wide, shallow sulcus, and the inner margins rather coarsely crenulate. Alt. 4.5, lon. 5.0, diam. 3.0 mm.

Only three valves of this form were obtained, but it seems to be distinct, though an evident precursor of *P. tenuisculptus*.

Phacoides (Bellucina) actinus n. sp.

PLATE 52, FIGURE 3.

Oligocene marl of Bowden, Jamaica; Henderson and Simpson.

Shell small, plump, somewhat inequilateral, with moderately prominent, slightly decurved beaks; anterior end longer and more inflated; lunule lanceolate, somewhat longer and narrower in the right valve, distinctly impressed; escutcheon impressed, almost linear; disk with sixteen to eighteen rounded radial ribs, entire and wider towards the base, with narrower deep interspaces; concentric sculpture of thin lamellæ, with much wider interspaces, which are somewhat crenulated or waved by overriding the ribs and dipping into the radial interspaces; dorsal areas large, slightly impressed, with no radial sculpture, the concentric lamellæ on the posterior area close-set, low, but on the bounding rib and on a radial line near the dorsal margin slightly elevated; hinge normal, delicate, internal margins minutely crenulate. Alt. 4.5, lon. 4.6, diam. 3.0 mm.

This little shell is near the typical *Parvilucina,* but begins to show the *Bellucina* characteristics in its sculpture, which in species of later horizons we find fully developed. The chief variations are in outline, some being rounder or higher and shorter than other specimens.

Phacoides (Bellucina) Tuomeyi n. sp.

PLATE 52, FIGURE 1.

Lucina costata Tuomey and Holmes, Pleioc. Fos. S. Car., p. 60, pl. xviii., figs. 12, 13, 1855. Not *L. costata* Orbigny, 1846, nor of Holmes, 1860, nor of Gabb, 1873.

Miocene of North Carolina at the Natural Well and Magnolia, Duplin County; and of South Carolina at Black River; Holmes.

Shell ovate-quadrate, solid, inequilateral, with small, pointed, inconspicuous beaks situated at about the posterior third; dorsal areas narrow, elongate, the posterior with one obsolete radial rib about the middle of it, the anterior without radial sculpture; disk with seven to nine flat radial ribs with somewhat narrower interspaces, which are shallow; the ribs become obsolete distally, sometimes as early as the middle of the adult disk; concentric sculpture of subequal low threads, with nearly equal interspaces, which do not become lamellose on the dorsal areas and cover the whole shell; lunule larger in the left valve, moderately impressed, cordate; escutcheon linear or obsolete; hinge normal, strong; inner margins very finely crenulate. Alt. 7.5, lon. 7.5, diam. 5.0 mm.

The above dimensions are above the average and taken from the largest specimen. The number of ribs is very commonly only seven.

This species has less prominent sculpture than the later ones and shows no leaflike lamellation or spinosity on the posterior dorsal area.

Phacoides (Bellucina) waccamawensis n. sp.

PLATE 52, FIGURE 2.

Lucina costata Dall, Trans. Wagner Inst., iii., p. 210, 1892; not of Tuomey and Holmes, 1855, or of Holmes, 1860.

Pliocene of the Waccamaw district, at Tilly's Lake, South Carolina, Johnson; and of the marls of the Caloosahatchie and Shell Creek, Florida, Dall and Burns.

Shell resembling *P. Tuomeyi* but smaller, more convex, with nine or ten radial ribs which are stronger and with deeper interspaces and which are very little feebler distally; the concentric sculpture is coarser and more prominent, and on the posterior rib and the medial ridge of the posterior dorsal area is raised into small leaflets or spines in perfect specimens. Near the base there frequently are small radial striæ between the ribs, and the lunule is much more conspicuous in the left valve. The hinge and crenulations much as in the last species. The largest valve found measured: Alt. 7, lon. 7, diam. (double) 6 mm.

This, the Pliocene form, is readily distinguished from *P. Tuomeyi* of the upper Miocene, though the general plan of ornamentation is the same.

Phacoides (Bellucina) amiantus Dall.

Lucina costata Holmes, P.-Pl. Fos. S. Car., p. 28, pl. vi., fig. 2, 1860; not of Tuomey and Holmes, 1855.

Phacoides (Bellucina) amiantus Dall, Synopsis Lucinacea, p. 826, pl. xxxix., fig. 10, 1901.

Pleistocene of Simmons Bluff, South Carolina; recent from North Carolina to the West Indies and San Sebastian, Brazil, in two to six hundred and forty fathoms.

This, the latest member of the series, is also the most elegant, the lamellations on the dorsal area being more prominent and numerous than in any of the others, the shell flatter, the concentric sculpture more regular, and the radial basal striation more extensive. *P. cancellaris* Philippi is the corresponding Pacific coast species, but it has not yet been reported in a fossil state.

Genus **DIVARICELLA** von Martens.

Divaricella von Martens, Beitr. z. Meeresf. Mauritius und Seychellen, p. 321, 1880, sole ex. *L. angulifera* von Martens, *loc. cit.*, pl. xxii., fig. 14; = *Lucina ornata* Reeve, 1850; not of C. B. Adams, 1852.

Cyclas Moerch (as of Klein), Cat. Yoldi, ii., p. 32, 1853 (not of Lam, 1799); first sp. *C. quadrisulcata* Orbigny, Conrad, Proc. Acad. Nat. Sci., vii., p. 30, 1856; H. and A. Adams, Gen. Rec. Moll., ii., p. 467, 1857; Stoliczka, Paleont. Indica, Pelecypoda, p. 252, 1870; Cossmann, Catal. Illustr., ii., p. 45, 1887.

Egraca (sp.) Leach, Moll. Gt. Brit., p. 310, 1852 (*L. divaricata*).

Strigilla (sp.) Turton, Dithyra Brit., p. 117, 1822; Gray, List of Brit. An., p. 98, 1851 (*Tellina divaricata* L.).

Strigella Gray, P. Z. S., 1847, p. 195; err. typ. pro *Strigilla*.

>*Lucinella* Monterosato, Nat. Sicil., p. 91, 1883; Nomencl. Med., p. 18, 1884; sole ex. *Lucina commutata* Philippi, Mol. Sicil., i., p. 32, pl. iii., fig. 15, 1836, = *Tellina divaricata* Linné, Syst. Nat., ed. x., p. 677, 1758; + *Cardium arcuatum* Montagu, Test. Brit., p. 85, pl. iii., fig. 2, 1803; + *C. discors* de Gerville (non Montagu), Cat. Coq. Manche, p. 18, 1825; + *Tellina digitaria* O. G. Costa (non Linné), Cat. List., pp. 14, 22, 1829; not *Lucina divaricata* of authors.

Lucina (sp.) of many authors, 1818–1880.

Loripes (sp.) S. Wood, Ann. Mag. Nat. Hist., vi., Nov., 1840, p. 248; Crag. Moll., ii., p. 137, 1853.

This group presents many of the characters of *Lucina* proper, but is well distinguished by its extremely characteristic sculpture. There are several recent species requiring close examination to discriminate. Nearly all these, together with most of the Tertiary species, were lumped together by early writers under the name of *Lucina divaricata*. The hinge when fully developed has the following formula: $\frac{\text{L. 1o1.1o}\frac{1}{2}\text{o.1}}{\text{R. o1o.o}\frac{1}{2}\text{o1.1}}$. The laterals are variable, especially the posterior laterals, which in some species are obsolete; the anterior laterals are more persistent, though usually feeble, and are situated near the cardinals at the anterior end of the lunule. The anterior and posterior dorsal areas are

usually absent; the lunule small and deeply impressed, unequal in the valves, as in many Lucinas, and larger in the right valve. The adductor scars are Lucinoid, the internal margins crenulate, the shell more or less orbicular, and generally rather convex. The species of the early Tertiary very often have the internal margin of the valves entire and some of them by their form indicate a transition towards the Lucinas. The following subdivisions may be recognized:

Section *Divaricella* s. s.

Valves suborbicular, subglobose, the umbones inconspicuous, the dorsal areas not indicated, the cardinals two in each valve, the ligament and resilium united, deeply inset but not strictly internal, the excavated striæ forming an angle on a line radial from the beaks. Type *D. ornata* Reeve. Mauritius.

Section *Pompholigina* Dall.

Valves extremely tumid, the umbones subspiral, the anterior and posterior dorsal areas indicated, the margins not crenulate; otherwise as in the typical section. Type *Lucina gibba* Gray. West Africa.

Section *Bourdotia* Dall.

Valves subcompressed, inequilateral, subquadrate, the anterior end produced, the anterior dorsal margin convexly arcuate, the internal margins plain, a single minute cardinal in each valve, the laterals obsolete; the excavated external striæ arcuate, not angulated. Type *Lucina* (*Cyclas*) *Bourdoti* Cossmann, Journ. de Conchyl., xxx., p. 115, pl. v., figs. 3 a–b, 1882. Parisian Eocene. This section is based on the figures and diagnosis cited.

Subgenus *Lucinella* Monterosato, 1883.

Shell like *Divaricella,* but the ligament obsolete, and the resilium wholly internal, as in *Semele.* Type *Tellina divaricata* Linné, better known as *Lucina commutata* Philippi. Mediterranean. This is also the type of *Cyclas* Stoliczka, 1870, non Lamarck, 1799.

Divaricella subrigaultiana O. Meyer.

Lucina (*Cyclas*) *subrigaultiana* O. Meyer, Bull. Ala. Geol. Surv., i., p. 81, pl. iii., figs. 13, 13a, 1886.

Vicksburgian Oligocene at Vicksburg, Mississippi; Meyer.

This is the earliest species of our Tertiary so far reported. I have not seen specimens.

Divaricella prevaricata Guppy.

Divaricella prevaricata Guppy, Proc. U. S. Nat. Mus., xix., p. 327, pl. xxx., fig. 4, 1896.

Oligocene of the Bowden marl, Jamaica.

Resembling *D. quadrisulcata* Orbigny but constantly smaller and weaker.

Divaricella chipolana n. sp.

PLATE 51, FIGURE 2.

Oligocene of the Chipola beds at the Chipola River and of the lower bed at Alum Bluff on the Chattahoochee River; upper Oligocene of the Oak Grove sands, Oak Grove, Santa Rosa County, Florida, Burns; Pliocene of the Brunswick Canal, Georgia, and of the Caloosahatchie beds of Florida.

Shell solid, subcircular, rounded in front and behind, equilateral, with inconspicuous beaks; sculpture of concentric incremental lines and an arcuate excavated sculpture (common to the genus and somewhat variable in minor detail in the species) as figured, and some obscure irregularly radial impressions on the anterior slope; lunule in the right valve short, small, rather broad; in the left valve none or hardly any; escutcheon none; resting stages variable, not conspicuous; hinge with strong cardinals and faint traces of the laterals, of which the right anterior lateral is best developed. Alt. 17, lon. 19, diam. 10 mm.

This species is especially characterized by its lunule, by the rounded, not angular, ends of the hinge-line, the absence of any denticulation of the margins due to the excavated sculpture, and the extremely fine crenulations of the rather broad margins.

Absent during the cold-water period of the Miocene, this form appears to return with the warmer Pliocene waters, again to disappear finally with the renewed cooling off of the waters in Pleistocene time.

Divaricella quadrisulcata Orbigny.

PLATE 51, FIGURE 1.

Tellina divaricata Dillwyn, Cat. Rec. Sh., i., p. 102, 1817 (*ex parte*), and many other authors.

Lucina divaricata Lamarck, An. s. Vert., v., p. 541, 1818 (partim), and many other authors, not of Linné; Say, Journ. Acad. Nat. Sci. Phila., p. 148, 1824; Conrad, Fos. Medial Tert., p. 39, pl. xx., fig. 3, 1840; Am. Journ. Sci., 2d Ser., i., p. 404, 1846; Gould, Inv. Mass., p. 70, 1841; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 59, pl. xvii., figs. 10–11, 1857; Emmons, Geol. Rep. N. Car., p. 291, 1858; Holmes, P.-Pl. Fos. S. Car., p. 27, pl. vi., fig 1, 1860.

Lucina quadrisulcata Orbigny, Voy. Am. Mér., Moll., p. 584, 1846; Moll. Cubana (Sagra), ii., p. 294, pl. xxvii., figs. 34–36, 1853; Arango, Moll. Cuba, p. 256, 1878.

Lucina (*Loripes*) *quadrisulcata* Mörch, Cat. Kierulf, p. 23, 1850.

Cyclas quadrisulcata Mörch, Cat. Yoldi, ii., p. 32, 1853.

Lucina Conradi Orbigny, Prodr. Pal., iii., p. 117, pl. xxi., fig. 94, 1852.

Cyclas Conradi Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 577, 1863.

Lucina strigilla Stimpson, Shells of N. Eng., p. 17, 1851.

Lucina americana C. B. Adams, Contr. Conch., p. 243, 1852; not of Defrance, 1823.

Lucina quadripartita Jeffreys, Brit. Conch., ii., p. 236, 1863 (lapsus).

Lucina commutata Dunker (MS. in Arango Moll. Cuba, p. 256, 1878); not of Philippi.

Cyclas dentata Verrill, Inv. An. Vineyard Sd., p. 686, pl. xxix., fig. 211, 1873 (not of Wood, 1815).

Lucina (*Divaricella*) *quadrisulcata* Dall, Bull. U. S. Nat. Mus. No. 37, p. 50, 1889.

Miocene of Maryland in Prince George County and elsewhere; of Virginia at City Point on the James River, Petersburg, and various points on the York River; of North Carolina at Wilmington, and the Natural Well and Magnolia, Duplin County; of South Carolina near Darlington; of Walton County, Florida, and of Texas in the deep artesian well at a depth of 2552 to 2600 feet below the surface; not reported from the Pliocene, but a depauperate smaller variety occurs at Simmons Bluff, South Carolina, in the Pleistocene; recent the species is reported living in ten to fifty fathoms from Nahant, Massachusetts, south to the West Indies and to Santa Caterina, Brazil.

This species and others were so long confounded with *D. divaricata* L. and *D. dentata* Wood that the early synonymy cannot be disentangled without more trouble than it is worth. The Miocene shells agree with the recent ones and do not occur in the Pliocene, where they are replaced by a type more nearly agreeing with the Oligocene *D. chipolana,* but appear to be represented in the Pleistocene by a form somewhat smaller and less developed than the recent shell, perhaps due to the lower temperature of that period. The chief characteristics of this species are the long, narrow, somewhat sinuous lunule, the straight hinge-line with the shell margin at its ends subangulate, the fine crenulation of the margin of the valves, and the absence dorsally of the rude denticulation due to the surface sculpture from which *D. dentata* Wood derived its name.

Divaricella dentata Wood.

Tellina dentata Wood, Gen. Conch., p. 195, pl. xlvi., fig. 6, 1815; Dillwyn, Descr. Cat. Rec. Sh., i., p. 103, 1817.

Lucina serrata Orbigny, Moll. Cubana, ii., p. 295; pl. xxvii., figs. 37–39, 1846.

Lucina Chemnitzii Philippi, Zeitschr. für Malak., iv., p. 151, 1848.

Lucina pilula C. B. Adams, Contr. Conch., p. 244, 1852.
Lucina divaricata Reeve, Conch. Icon.

Pleistocene of St. Domingo, Gabb; living from Cape Hatteras, North Carolina, to Brazil in ten to sixty fathoms.

This species can be identified by its extremely small, deep, cordate lunule, its serrate dorsal margins, and frequently by its greater size and solidity. I have seen no fossil specimens; those reported from the Galveston well and elsewhere on examination prove to be referable to *D. quadrisulcata.*

Divaricella compsa n. sp.

Plate 51, Figure 3.

Pliocene of the Caloosahatchie marls on Shell Creek, Florida; Burns.

Shell small, thin, subequilateral, rounded, moderately convex, with rather elevated beaks; surface sculpture that of the genus, but finer and more even than in any other American species; line of the chevron-shaped angle narrow, extending from the beaks to a point on the base somewhat in front of the middle of the valves; lunule rather elongate-lanceolate in shape but very small, and almost wholly confined to the right valve; margins not denticulated by the external sculpture, but internally very finely crenulate; hinge small, but the teeth conspicuous, the laterals well marked; the ends of the hinge-line rounded off. Alt. 11.5, lon. 12.5, diam. 8.0 mm.

This little shell is distinguished by its sculpture, which is uniformly fine, more so than in even the young of the other species, and by its almost obsolete narrow lunule. The figure given, though in the main accurate, hardly represents the sculpture as sufficiently fine, compared with the other species.

In closing it may be remarked that the term *Cyclas,* introduced from the non-binomial Klein by Mörch, and adopted by H. and A. Adams and Stoliczka, was intended to cover the genus here referred to *Divaricella.* Conrad, however, used it as a synonym of *Lucina, senso lato,* and not as the equivalent of this group. The word *Cyclas,* having been introduced into binomial nomenclature by Bruguière, and restricted by Link in 1807, is not available for another genus.

The genus *Divaricella* is stated by Stoliczka to extend into the Cretaceous, but so far none of earlier date than the Oligocene have been reported in this country.

Family CORBIDÆ.

Genus **CORBIS** Cuvier.

Gafrarium (sp.) Bolten, Mus. Boltenianum, p. 176, 1798.
Corbis Cuvier, Règne Anim., ii., p. 480, 1817; sole ex. *Venus fimbriata* Linné, S. N., x.,

p. 687, 1758; Born, Test. Mus. Vindob., p. 69, pl. v., fig. 4, 1780; Chemn., Conch. Cab., vii., p. 52, pl. xliii., figs. 448–9, 1784.

Fimbria Megerle, Mag. Ges. Naturf. Fr. zu Berlin, p. 52, 1811 (*F. magna* Megerle); Blainville, Man. Malac., p. 551, 1825; not of Bohadsch (Nudibranchiata), 1761.

Idothea Schumacher, Essai, p. 160, 1817; sole ex. *Venus fimbriata* L.; not *Idotea* Fabricius (Crustacea), 1793.

>*Bernayia* Cossmann, Cat. Illustr., p. 20, 1887; ex. *B. subarata* Cossm., *op. cit.*, pl. iii., figs. 6–7, 1887; not *Bernoyia* Jousseaume, 1884.

?>*Parvicorbis* Cossmann, Cat. Illustr., Suppl., p. 32, 1892, = *Bernayia* Cossm. non Jouss.

The genus *Gafrarium* of Bolten comprised, among the identifiable species catalogued under that name, one species subsequently made the type of *Corbis* Cuvier, six species based on varieties of *Venus pectinata* Gmelin (= *Crista* Römer, 1857; *Circe pectinata* of authors), and one peculiar *Venus* (*reticulata* Linné, Syst. Nat., ed. x., p. 687, 1758; Chemnitz, Conch. Cab., vi., p. 367, pl. xxxvi., figs. 382–3, 1782), which is of the same type as those reserved to carry the name *Cytherea* Bolten. In my "Synopsis of the Lucinacea" (Proc. U. S. Nat. Mus., 1901), not having reviewed the *Veneridæ*, I proposed to retain the name *Gafrarium* for the species of *Venus* like *V. reticulata*. But since this is a *Cytherea* the name must rest on one of the other groups if it is to be retained, and, since six of Bolten's nine identifiable species are referable to the group typified by *Circe pectinata*, it would seem that the change must best be made here, though in so doing my hope of avoiding changes in well-accepted names is frustrated.

The subgenus *Bernayia* Cossmann non Jousseaume, = *Parvicorbis* Cossmann, I know only by the figures; it seems from them to be probable that it should find a place near *Scintilla* and its allies, and not in the *Lucinidæ*, none of which gape.

The American species, so far as known, are all Eocene, few in number, and rare as individuals.

Corbis undata Conrad.

Corbis undata Conrad, Fos. Tert. Form., p. 41, 1833; Harris reprint, p. 41, pl. xix., fig. 6; Am. Journ. Sci., 2d Ser., i., p. 401, pl. iv., fig. 11, 1846.

Corbis undulata Conrad, Morton, Synopsis Org. Rem., App., p. 7, 1834 (lapsus for *undata*).

Corbis distans Conrad, Fos. Tert. Form., p. 41, 1833; Morton, Syn. Org. Rem., App., p. 7, 1834; Am. Journ. Sci., 2d Ser., i., p. 401, pl. iv., fig. 11, 1846 (young shell).

Gafrarium distans Conrad, Am. Journ. Conch., i., p. 9, 1865.

Claiborne sands at Claiborne, Alabama.

Conrad described the adult (*undata*) and young (*distans*) shells as separate species in 1833; he united them under the name of *undata* in 1846; in 1865, having apparently forgotten this consolidation, he united them a second time under the name of *distans*. The first rectification, of course, must take precedence.

Corbis claibornensis Dall.

Corbis lamellosa Conrad, Morton, Syn. Org. Rem., App., p. 7, 1834; Bull. Nat. Inst., ii., p. 175, 1842; name only; not of Lamarck.

Corbis lamellosa Conrad, Am. Journ. Sci., 2d Ser., i., p. 401, pl. iv., fig. 16, 1846; not of Lamarck.

Gafrarium liratum Conrad, Am. Journ. Conch., i., p. 9, 1865; not *Lucina* (*Corbis*) *lyrata* d'Archiac, Géol. de l'Aisne, p. 372, pl. xxvi., fig. 3, 1840.

Claiborne sands, at Claiborne, Alabama; rare.

This elegant shell was at first wrongly identified with a European species by Conrad, and in 1865 renamed, but, unfortunately, the name selected had already been used for another European species, so that a new name is necessary and is proposed as above.

The shell described by Conrad in 1848 (Proc. Acad. Nat. Sci. Phila., iii., p. 293, 1848; and Journ. Acad. Nat. Sci. Phila., New Ser., i., p. 124, pl. xiii., fig. 20) is doubtfully referable to this genus and requires further examination. It was described from the Vicksburgian horizon and has no radial sculpture. Sowerby has described a South American species collected by Darwin from Chile under the name of *lævigata*, but it is not the *C. lævigata* of Lycett, Ann. Mag. Nat. Hist., 1850, p. 423.

Superfamily CHAMACEA.

Family CHAMIDÆ.

Genus **CHAMA** (Linné) Bruguière.

<*Chama* Linné, Syst. Nat., ed. x., p. 691, 1758; Kämmerer, Conch. Cab. Schw. Rudolstadt, p. 193, 1786. First species *C. lazarus* Linné.

Chama Bruguière, Enc. Méth. (Hist. Nat. des Vers., i., pt. 2), vi., pp. xiii., 1789, and 385, 1792; Mus. Boltenianum, 1st ed., p. 195, 1798; Cuvier, Tableau Elém., p. 429, 1798; Lamarck, Prodrome, p. 81, 1799; Link, Beschr. Rostock Samml., p. 154, 1807; Schumacher, Essai, p. 128, pl. vi., fig. 4, 1817; Mörch, Cat. Yoldi, ii., p. 36, 1853; H. and A. Adams, Gen. Rec. Moll., ii., p. 463, 1857. Type *C. lazarus* Linné (not Lamarck); cf. Born, Test. Mus. Vind., pl. v., figs. 12–14, 1788. = *C. damœcornis* Lamarck, 1818.

Macerophylla Meuschen, Mus. Gevers., p. 430, 1787 (nomenclature not Linnean).

Psilopus + *Psilopoderma* Poli, Test. Utriusq. Siciliæ, ii., p. 253, 1795 (nomenclature not Linnean).

Psilopus Oken, Lehr. d. Naturg., p. 231, 1815.

Psilopododerma Agassiz, Nomencl. Index, 1848.

Lacinia "Humphrey," Mus. Calonn., pp. 53, 85, 1797.

Maceris Modeer, K. vetensk. Ac. nya Handl., xiv., pp. 174, 182, 1793.

Planospirites Lamarck, Syst. An. s. Vert., p. 400, 1801 (*fide* Deshayes MS.); Bosc, Hist. Nat. Coq., iii., p. 237, 1802; Roissy, Moll., v., p. 245, 1805; sole ex. *P. ostracina* Lam., from the Cretaceous of Maestricht.

?Hellia Schafhäutl. (I have not been able to obtain this reference.)

Goossensia Cossmann, Journ. de Conchyl., xxxiii., p. 113, 1885; Cat. Illustr., ii., p. 102, 1887. Type *Cardita irregularis* Desh.

Omitting reference to the peculiar Mesozoic *Chamidæ* for which no adequate material is available, the typical members of the family appear only in the later Cretaceous and reach their apogee in the Tertiary. The Tertiary and recent *Chamidæ* include two genera, *Chama* and *Echinochama*, the latter making its début in the Oligocene.

The Linnean genus was heterogeneous, and it remained for Bruguière to restrict the group to nearly its natural limits, excluding uncongenial forms. Such names as *Globus, Stola, Jataronus, Macerophylla, Psilopus,* and *Psilopoderma* belong to pre-Linnean authors or non-Linnean nomenclature and have merely an antiquarian interest. The group is tropical or warm-temperate in distribution and world-wide in range.

It has been very difficult to obtain material for determining the original dentition in this group. Bernard had nothing less than five millimetres in diameter, at which age those species with the largest protoconch have the hinge much altered. Species with a small protoconch at that diameter show nothing of the original hinge. The deep-water species and *Echinochama* have larger protoconchs than the average species of the strand, and are therefore more convenient for study, but in seventeen years search for protoconchs which have not become attached has only resulted in obtaining two valves, though a great deal of small material was picked over. By the study of the smallest attainable fixed individuals something has been made out. (See pl. liii., fig. 1.)

In all Chamas the protoconch is a small, polished, inflated shell, rounded or subquadrate, which in average species reaches a diameter of 0.15 millimetres, and, in such forms as *C. congregata., C. pellucida,* etc., almost immediately shows in its growth the characteristics of the adult and becomes attached to some convenient object when from three to five millimetres in diameter. The

polish of the protoconch is quickly lost by friction, to which sessile mollusks in shallow water are particularly liable, and one needs, to secure a satisfactory study of this early stage, very young and lately attached individuals. In other species, such as *C. lactuca* (from one hundred fathoms) and *Echinochama,* the growth of the protoconch continues without material change until the valves reach a length perhaps of two millimetres, the nepionic shell usually developing concentric lamellæ at regular intervals and having the interspaces smooth and polished, or radially or concentrically striated. Having reached this size a more or less sudden change takes place, and the adult sculpture is assumed. Though the animal may not become sessile at once, it does so very shortly after this new type of growth is exhibited; in which state it was referred by Deshayes to the genus *Cardita,* to which, in a wide sense at this stage, it does belong conchologically. With the sessile condition and the inability of the shell to grow normally as before a kind of rotation results, and the ligament and hinge-teeth are obliged to grow rapidly in a posterior direction, and the form of the teeth becomes crude and obscure, being governed more by the dynamics of its sessile state than by the hereditary model of hinge-teeth thus left behind in growing. The dynamics of the hinge being practically the same whichever valve is attached, the curious fact that in this genus the attached valve always presents a similar hinge condition (whether the valve be right or left) is accounted for.

The hinge of the left valve of the protoconch of *Echinochama* at about two millimetres length shows a ligament with no conspicuous nymph, a single large cardinal slightly mesially grooved, and the rudiment of a second cardinal in front of the large one near the dorsal border. In a specimen 4.5 millimetres in length a callosity which may represent a third cardinal is developed on the ventral side of the nymph, and is on its dorsal aspect distinctly crenulated. The large middle cardinal has become relatively smaller and is now connected rather obscurely with the anterior cardinal, which has elongated and become proportionately larger, while below it on the margin of the hinge-plate a small corrugated thickening is perceptible. There is no trace of an anterior lateral at any stage or in any species I have been able to study; if present, it has become obscured by the marginal crenulations. The posterior lateral is, however, quite distinct in most cases in both valves. In the right valve at this stage there are two simple, subequal, diverging cardinals, but no callosity on the nymph. The formula is $\frac{L.\ 1.10101.}{R.\ 1.01010.}$. As growth continues the teeth become tumid and corrugated, more or less irregular within the limits of the species, but in a general way the attached valve has a ventral and one or two dorsal corrugated ridges

replacing the cardinals, while the free valve has an arcuate ridge corrugated on both sides which fits between those of the opposite valve. These are developed by the deposition of shell substance at first on and about the original cardinals, connecting, modifying, or submerging them, but they are soon left behind by the rotation of the valves and hinge. The small posterior laterals are almost always discoverable. In the two millimetres stage the adductor scars are small but distinct, the pallial line broad, entire, and slightly irregular; there is a distinct escutcheon but no lunule. The young of *Chama,* unlike *Echinochama,* shows an anterior right lateral received into a socket in the margin of the left valve, as in the specimen of *C. pellucida,* much magnified, which has been figured on Plate liii., Figure 1, of this volume.

The shell of *Chama* consists of three layers: the outer chalky, frequently brightly colored, and with a partially reticulated tubular structure microscopically. The middle layer is heavier, more glassy, and prismatic, while a thin layer of chalky appearance, vertically tubular, lines most of the shell. The periostracum of many Chamas is fugacious or very tenuous. A few species have a heavy brown cortex, which, in the *C. inermis* Dall, of the Panama fauna, in some unexplained manner is covered by an outer coating of shelly matter sometimes five millimetres thick, and, where thinner and translucent, allowing the periostracum to be seen through it distinctly. Some other species seem to indicate a similar arrangement, but in the *C. inermis* the superposition is patently obvious.

According to Fischer, seventy-five per cent. of the recent species of *Chama* attach themselves by the left valve; one species is cited as selecting either valve indifferently.

In the typical *Chama* the shell is sessile, very inequivalve, with the free valve (as in all sessile mollusks) flatter, with more or less lamellose or spiny irregular sculpture; there is no defined lunule; the ligament is narrow, set in a deep, narrow groove, revolving with the rotation of the valves, the resilium sometimes partly separated and deeply submerged; the pallial sinus simple, the adductor scars large, subequal, usually rough, the mantle adhering by minute processes which penetrate the tubules of the inner shell layer in some species.

In the genus *Echinochama* the shell is nearly equivalve, and sessile in most cases only while young; the sculpture is radial, spinose, and regular; a large impressed and conspicuous lunule exists, and also an obscure escutcheon. It is confined to tropical American waters in the recent fauna, while *Chama* exists all over the world in the warmer waters.

The name *Chama* is derived from a Greek word meaning a *hiatus* or a gaper,

and hence Da Costa and some of the other early writers objected to the Linnean use of it for a genus which closes very tightly, but the objection has not been sustained. The type of *Chama* Da Costa is *Mya truncata.*

As is natural, owing to their variability and the fact that the spines or lamellæ may in individuals become obsolete, the number of species of *Chama* seems to have been exaggerated by authors. On the other hand, these very factors render it more difficult to discriminate between nearly allied species which may really deserve separation.

A group based on the nepionic young of *Chama* has been named *Goossensia* by Cossmann and appropriately placed in the *Carditidæ,* of which I believe our modern *Chamidæ* to be an offshoot. I have not the material suitable to base an opinion upon as to the origin of the early Mesozoic forms which have been referred to this family, but should not be surprised if a sufficiently thorough study showed that they are less intimately connected with the Tertiary and recent forms than has been supposed, the characteristics upon which their alliance has been assumed being dynamic rather than genetic. It is not improbably a case similar to that of *Hinnites,* in which the forms existing in different epochs have diverged sporadically from the contemporaneous *Pectinidæ* and have no direct genetic connection from one horizon to another.

The mutations within the species of *Chama* are quite marked. They comprise color variations which are often quite striking, as lemon-yellow and pale or dark purple in *C. macerophylla,* profuse, sparse, or obsolete foliation, and such changes of form as are due to the object upon which they are fixed. In discriminating species these fluctuations should be taken into account by the student, but it will also be found that there are features which are tolerably constant and which, after due discrimination, will be found to serve as guides to specific identity.

Chama mississippiensis Conrad.

Chama mississippiensis Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 294, 1847; Journ. Acad. Nat. Sci. Phila., 2d Ser., i., p. 124, pl. xiii., figs. 21, 27, 1848; Checkl. Eoc. Fos. N. Am., p. 27, 1866; Am. Journ. Conch., i., p. 7, 1865.

Vicksburgian Oligocene at Vicksburg and at Red Bluff and other localities in Wayne County, Mississippi; in Louisiana, near Mt. Lebanon; Vaughan.

This is quite a small species attached by the right valve and with low, sparse, pustular spines.

An Eocene species from the upper Midway limestone has been described by Harris (Bull. Pal., i., p. 180, pl. vi., figs. 4, 4a, 1896) under the name of *C.*

gainesensis, and this is the earliest of our known Tertiary species. It is attached by the left valve, is small, and concentrically simply lamellose.

Chama involuta Guppy.

Chama involuta Guppy, Geol. Mag., dec. ii., vol. i., p. 444, pl. xvii., figs. 5a–c, 1874.

Oligocene marl of Bowden, Jamaica; Guppy, Henderson, and others.

This is a small species, attached by the left valve, with the sculpture of the valves discrepant. The attached valve has a vermiculately verrucose surface with a few distant rows of low radial spines, sometimes obsolete; the free valve has low, fluted, concentric lamellæ.

Chama chipolana n. sp.

Plate 56, Figures 19, 20.

Oligocene marls of the Chipola horizon on the Chipola River and at Alum Bluff on the Chattahoochee River, Calhoun County, Florida, Burns and Dall; in the silex beds at Ballast Point, Tampa Bay, and in the Oligocene sands of Oak Grove, Santa Rosa County, Florida, Burns and Aldrich.

Shell irregular in shape, but usually rounded, with the lower valve deep and the upper one nearly flat, with a rotation of nearly two whorls in old specimens; sculpture of the attached valve (usually the left but sometimes the right) low, irregular, concentric lamellæ and rounded radial ridges, which become on the lamellæ short channelled spines; the radials vary in size but are usually close-set; the free valve has the concentric sculpture more or less suppressed, the radials finer and more regular, hardly spinose; there are frequently radials on which the spines are better developed set at regular intervals, the intervening radials without spines; the adductor scars are rather short and rounded; there is a polished, smooth border between the pallial line and the margin, the latter being finely radially grooved or striate. The shell is commonly an inch in diameter but reaches twice or thrice that size in senile individuals, judging from fragments obtained.

Two small valves are figured, since the older valves are invariably worn and do not show the sculpture well.

Chama tampaensis n. sp.

Plate 54, Figure 6.

Oligocene silex beds at Ballast Point, Tampa Bay, Florida; Dall and Burns.

Shell rather small, irregular, attached by the left valve; sculpture of concentric lamellæ, on the attached valve sparse and irregular, not fluted or crenulated, on the right valve rather more evenly spaced, though sometimes crowded,

usually somewhat distant, smooth, or faintly radially striated, except at the extreme margin, where there are obsolete flutings on one or two of the outermost lamellæ if any; internal margins of the valves smooth; average diameter about twenty millimetres.

Most of the specimens are somewhat worn, though the shell is abundant, but it seems clearly distinct from *C. chipolana.*

Chama draconis n. sp.

PLATE 56, FIGURES 17, 18.

Oligocene of the Chipola marl, Chipola River, Calhoun County, Florida; Burns and Dall.

Shell irregular, attached by the anterior end of the right valve, which usually acquires a trigonal or semicircular outline; sculptured on the right valve with a curious, blistered verruculation not unlike convex scales of a saurian or Gila monster, and also at the margin of the attachment with broad, irregular, concentrically striated foliations; on the posterior slope there is a tendency to form two or three radial series of small, rather distant foliations, which, or part of them, are often obsolete; near the posterior dorsal margin is a well-marked radial sulcus and often another parallel to it but much more feeble; left valve much flatter, irregularly concentrically lamellose, the lamellæ rising into foliations in two or three radial series behind, the foliations and most of the surface with fine vermicular or partly divaricate radial fluting or threading; adductor scars small; internal margins finely crenulate. Average diameter about twenty-five millimetres.

This is a rather common species with a surface recalling that of *Echinochama.*

Chama Lyelli n. sp.

PLATE 54, FIGURE 3.

Oligocene limestone (horizon of *Cerithium georgianum*) of Jacksonboro', Georgia; Vaughan and Whitfield.

Shell of moderate size, represented only by casts, attached by the left valve; the latter concentrically profusely lamellose, normal form rotund; right valve concentrically lamellose; the lamellæ radially fluted, the alternate flutings produced as long, smooth, radiating spines, sometimes half as long as the diameter of the valve; internal margin smooth. Diameter, excluding the spines, about twenty-five millimetres.

This species is imperfectly represented by the casts, but the sculpture is unlike that of any other American species, recent or fossil, and will identify it.

The horizon appears to be a little higher than the Tampa silex beds and equivalent to the Tampa limestone, a fact demonstrated by the researches of Mr. T. W. Vaughan of the United States Geological Survey.*

Chama corticosa Conrad.

Chama corticosa Conrad, Am. Journ. Sci., xxiii., p. 341, 1833; Fos. Medial Tert., p. 32, pl. xvii., fig. 3, 1838; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 22, pl. vii., figs. 1, 2, 3, 1855; Emmons, Geol. Rep. N. Car., p. 288, fig. 210, 1858; Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 576, 1864; Meek, Checkl. Miocene Fos. N. Am., p. 8, 1864.

Miocene of the James River, Virginia (type locality); of the York River near Yorktown, Harris; of Petersburg, Burns; of the Darlington district, South Carolina, Tuomey and Burns.

This is a large, rather rude species attached by the right valve, with crenulate inner margins and radially striated, rather closely appressed, concentric lamellation. The average diameter is about fifty-five millimetres.

Chama congregata Conrad.

Chama congregata Conrad, Am. Journ. Sci., xxiii., p. 341, 1833; Fos. Medial Tert., p. 32, pl. xvii., fig. 2, 1838; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 23, pl. vii., figs. 7 to 10, 1855; Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 576, 1864; Whitfield, Miocene Moll. N. J., p. 65, pl. ix., figs. 14–18, 1895.

?Chama foliacca Gmelin, Syst. Nat., vi., p. 3304, 1792; after Lister, t. 215, f. 51.

Miocene of Shiloh and Jericho, Cumberland County, New Jersey, Burns; of Plum Point and Church Hill, Maryland; of the York and James Rivers, of Petersburg and Dinwiddie, and Prince George County, Virginia; of South Carolina near Darlington; of Florida at De Leon Springs, Jackson Bluff, and sixteen miles southwest of Tallahassee; also recent on the coast.

This is a small, very plump species, rudely frilled and fluted on both valves, the flutings on the free valve sometimes recurving as very short, close-set

* It is well to state here that some of this limestone has long been in the National Museum with the label "White limestone of Claiborne, Alabama," furnished by an eminent paleontologist whose labels must in some way have got mixed. Several species included in this work have been described from these casts and referred to Claiborne, whereas they form a part of the Jacksonboro' fauna. Of these Mr. Vaughan by examining the collection has been able to make the following enumeration: *Bulla pctrosa* Conrad; *Strombus albirupianus* Dall (p. 174); *Cerithium georgianum* Lyell; *Calyptræa trochiformis* Lamarck; *Xenophora humilis* Conrad; *Amauropsis ocalana* Dall (p. 377), and *Ampullina streptostoma* Heilprin, besides others not specifically identified.

spinules. It is usually attached by the beak of the left valve, which is quite turbinate, a single valve recalling a specimen of *Neritopsis*. The average diameter is about twenty-eight millimetres, and the internal margins are crenulated.

This appears to be the species said to be abundant in Cuba, which is cited by Arango (p. 272) as *Chama foliacea* Gmelin, based chiefly on Lister's figures. It is, however, too uncertain to be adopted even if the specific name was not so glaringly inappropriate.

Chama striata Emmons.

Chama striata Emmons, Geol. Rep. N. Car., p. 286, fig. 211, 1858; Conrad, Proc. Acad. Nat. Sci. Phila. for 1863, p. 576, 1864; Meek, Checkl. Miocene Fos. N. Am., p. 8, 1864.

Upper Miocene of North Carolina at the Natural Well and Magnolia, Duplin County; of Florida, sixteen miles southwest of Tallahassee; Pliocene of Tilly's Lake, Waccamaw district, South Carolina, and of Shell Creek and the Caloosahatchie River, Florida.

A small species attached by the left valve with a strong sulcus near the posterior dorsal margin of that valve; the free valve obscurely divided into three lobes by two broad, shallow, radial sulci on the posterior half of the shell; the sculpture is of fine flutings with occasionally two or more radial series of small, distant, squarish foliations. The margins are finely crenulate and the average diameter is about twenty millimetres. The adductor scars are rather long.

Emmons' figure is quite inadequate to give any sufficient idea of the species. It may prove to be a dynamic mutation of some other species, but Emmons, Meek, and Conrad, all good judges, regarded it as distinct.

Chama Willcoxii Dall.

PLATE 41, FIGURES 5, 6, 7.

Chama Willcoxii Dall, Trans. Wagner Inst., iii., p. 1197, pl. xli., figs. 5, 6, 7, 1900.

Pliocene of the Caloosahatchie beds on the Caloosahatchie and Shell Creek, Florida; Willcox, Burns, and Dall.

Shell large, solid, lamellose, normal or attached by the left valve; beaks prosogyrate, their coil forming about two turns; both valves with a strong furrow extending from the beaks to the lower posterior margin, but more or less obscured by the lamellation; both valves similarly sculptured with numerous, close-set, arched lamellæ more or less fimbriated, sharply, closely, radially grooved on the upper surface, and for the most part distally appressed towards the valve, especially on the fixed valve, the under surfaces concave or

spoon-shaped; general form irregular; the specimen figured is more transverse than usual; hinge normal, the teeth not very prominent; ligament and resilium coherent, equally long, extending into a deep groove below the broad surface of attachment; visceral area of the valves smooth with a marginal smooth border; the outer edge is minutely granular, outside of which is a more or less irregularly radiately striate or granular margin to the edge of the valves; adductor scars well marked. Lon. of figured specimen 83, alt. 68, diam. about 45 mm.

This fine species recalls *C. macerophylla,* but differs in the posterior furrow, the radially grooved and appressed lamellæ, and apparently in being larger when adult. It was found at Shell Creek, where it was not very rare, and sparsely on the Caloosahatchie near the site of old Fort Denmead, at a point called Fourmile Hammock.

Chama crassa Heilprin.

Chama crassa Heilprin, Trans. Wagner Inst., i., p. 93, pl. xii., fig. 27, 1887.

Pliocene marl of the Caloosahatchie; Heilprin and Dall.

This species is easily recognized by its ponderous valves exhibiting two or more whorls, with close, low lamellation, devoid of spines or foliations, and of a turbinate shape with a deep, wide, radial posterior sulcation. In perfect specimens the appressed margins of the lamellæ are radially striate. It has the character, very rare in *Chama,* of entire, non-crenulate inner margins to the valves. The most nearly related recent species is perhaps *C. lobata* of the Pacific.

Chama caloosana n. sp.

PLATE 54, FIGURES 2, 5.

Pliocene marls of the Caloosahatchie, Shell Creek, and Alligator Creek, south Florida, Dall and Burns; Pliocene of Trinidad Island at Matura, Guppy.

Shell of moderate size, attached by the whole of the anterior end of the right valve, with a sharp, narrow, radial sulcus near the posterior dorsal border, on each side of which in the normal individual is a radial series of a few, flat, triangular, radially striated foliations; in specimens having no foliations the sulcus is inconspicuous; the surface otherwise is concentrically striate with traces of obsolete oblique or even divaricate radial threading; the left valve is flattish, subquadrate, with an analogous but narrower sulcus bordered with flat, radially striate foliations; there are sometimes a few anterior foliations and the divaricate surface sculpture is more apparent than on the fixed valve;

the inner margins are crenulate and the average diameter is about thirty-five millimetres.

A variety is entirely without foliations, the sulci obsolete, and the divaricate sculpture stronger than usual. A specimen from the Caloosahatchie has smooth internal margins and a diameter of fifty-five millimetres.

The shell identified with the Indo-Pacific *Chama ruderalis* Lamarck by Guppy (Paria Fauna, p. 153, 1877) from the Pliocene of Matura, Trinidad, appears, though of rather small size, to be identical with this species.

Chama macerophylla Gmelin.

Chama gryphoides (*ex parte*) Linné, Syst. Nat., ed. xii., p. 1139, 1767; Dillwyn, i., p. 221, 1817.

Macerophylla, Flos Macis, etc., Chemnitz, Conch. Cab.; vii., pp. 101, 149, pl. lii., figs. 514–15, 1784.

Chama macerophylla Gmelin, Syst. Nat., vi., p. 3304, 1792; Orbigny, Moll. Cubana, ii., p. 363, 1853.

Chama citrea Gmelin, *op. cit.,* p. 3305, 1792.

Chama lazarus Lamarck, An. s. Vert., vi., p. 93, 1819; Deshayes, *op. cit.,* ed. ii., vi., p. 579. 1835 (not of Linné); Kurtz, Cat. Sh. N. and S. Car., p. 6, 1860.

Chama macrophylla Hanley, Descr. Cat. Rec. Biv. Shells, p. 226, 1843; Reeve, Conch. Icon., iv., pl. ii., fig. 6, pl. viii., fig. 6b, 1846–7; Arango, Fauna Mal. Cubana, p. 272, 1878; Krebs, W. I. Mar. Sh., p. 117, 1864; Tryon, Am. Mar. Conch., p. 177, 1874.

Chama macerophylla var. *purpurascens* Poulsen, Cat., p. 15, 1878; and var. *sulphurea, ibidem,* not of Reeve, 1846.

Chama bicornis Krebs, W. I. Marine Sh., p. 117, in syn. (not of Linné), 1864.

Chama imbricata "Lmk.," Krebs, *op. cit.,* p. 117 (not of Broderip); Arango, Fauna Mal. Cubana, p. 272, 1878.

?*Chama sinuosa* Broderip, Trans. Zool. Soc., i., p. 303, pl. xxxix., fig. 11, 1833; Reeve, Conch. Icon., iv., pl. iii., fig. 11, 1846.

Pleistocene of Cuba, the Antilles, and Curaçao, Orbigny and Lorié; living from Cape Hatteras, North Carolina, to and throughout the Antilles and southward to the Abrolhos Islands on the east coast of Brazil.

This well-known species was named from the fancied resemblance of the foliations to the ramifications of mace, or, as anciently called, the "flower of the nutmeg;" and hence the orthography *macrophylla,* due originally to an error of the usually most accurate Hanley, is inadmissible.

The species when best developed has flattish foliations with obsolete radial striation upon them and is attached by the left valve. The living shell may be purple, lemon yellow, or white, and the earlier foliations are semicylindrical.

It is best discriminated from the allied *C. ferruginea* Reeve, of the same faunal region, by the fact that the other species is attached by the right valve, and when colored is usually of a reddish brown, with sharp radial striation on the foliations, which are more or less restricted to radial rows.

C. ferruginea; C. variegata Reeve, 1847; *C. florida* Lamarck, 1819 (+ *C. sarda* Reeve, 1846), and *C. lactuca* Dall, 1886, species now existing on the coast, are not yet reported in the fossil state.

Since the above account of our Chamas was prepared Aldrich has described and figured in the "Nautilus" (xvi., p. 100, pl. iv., fig. 15, Jan., 1903) *Chama monroensis* from the Eocene *Ostrea sellæformis* bed at White's marl-pit, Monroe County, Alabama. It is a lamellose species with paired radial riblets.

Genus ECHINOCHAMA Fischer.

Arcinella Schumacher, Essai, p. 142, pl. xiii., fig. 1, 1817 (type *Chama arcinella* Linné); Mörch, Cat. Yoldi, ii., p. 37, 1853; Sowerby, Man. Conch., 2d ed., p. 72, 1842 (not *Arcinella* Oken, Lehrb. der Naturg., viii., pp. 236, 238, = *Cardita* Brug.; or *Arcinella* Philippi, Enum. Moll. Sicil., ii., p. 53, 1843, *Mytilidæ*).

Echinochama Fischer, Man. de Conchyl., p. 1049, 1887. Type *Chama arcinella* Linné.

The presence of a large and impressed lunule, the peculiar surface, the nearly free habit in the adult state, and the large protoconch separate this group sufficiently from the genus *Chama*. The number of species is small. The type, which is West Indian and Pliocene, and *E. californica* Dall, from Lower California (which differs from *E. arcinella* by its flatter, larger, and more quadrate valves, less prominent beaks, less impressed lunule, more numerous ribs and longer spines), are not yet known in the fossil state. The following species carries the group back to the Oligocene. All the species adhere when young by the right valve.

Echinochama antiquata n. sp.

PLATE 54, FIGURE 9.

Chama arcinella Guppy, Geol. Mag., dec. ii., vol. i., p. 450, 1874; not of Linné.

Oligocene of Bowden, Jamaica, and Haiti, West Indies.

Shell large, subquadrate, with an almost absolutely rectilinear base, slightly arched posterior and dorsal edges, and excavated anterior end; valves less convex than in *E. arcinella* and with less prominent and inflated beaks, larger and less impressed lunule; the number of ribs varies from twenty-two to thirty-one, low with subequal interspaces, the spines very short and scalelike except on a single median rib, where they are triangular and somewhat longer than on

the rest; surface sculpture more pustular and less regular than in *E. arcinella.* Length 50, height 48, diameter about 40 mm. exclusive of the spines.

This species when compared is seen to be very distinct from the type of the genus with which it was confused by Guppy and is really more like the Pacific species, which has nearly as many ribs but differs by having a smaller and less impressed lunule and long, cylindrical spines.

All the species have occasional individuals which have the spines and even the ribs nearly obsolete. Guppy's Haitian specimen, and a valve collected in the Pliocene of Moen, Costa Rica, by Gabb, are of this character, but as it is more an individual mutation than a true variety I shall not apply any distinctive name to it.

Echinochama arcinella Linné.

Chama arcinella Linné, Syst. Nat., ed. xii., p. 1139, 1767; Reeve, Conch. Icon., iv., pl. v., fig. 26 a, b, 1846; Orbigny, Moll. Cubana, ii., p. 362, pl. xxviii., figs. 28, 29, 1853 (variety with long spines).

Cardium cristagalli Martyn, Univ. Conch., pl. cxxxii., fig. 1, 1789 (variety with long spines).

Arcinella spinosa Schumacher, Essai, p. 142, pl. xiii., fig. 1, 1817.

Cardium histrix Martyn, Univ. Conch., pl. cxxxii., fig. 2, 1789 (variety with short spines).

Chama arcinella Conrad, Am. Journ. Sci., 2d Ser., i., p. 404, 1846; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 22, pl. vii., figs. 4, 5, 6, 1855; Emmons, Geol. Rep. N. Car., p. 287, fig. 209, 1858; Holmes, Pleist. Fos. S. Car., p. 23 (pl. v., fig. 1, excl.), 1860; Meek, Checkl. Mioc. Fos. N. Am., p. 8, 1864; Gabb, Geol. St. Dom., p. 251, 1873; Heilprin, Trans. Wagner Inst., i., p. 103, 1887.

Arcinella arcinella Mörch, Cat. Yoldi, ii., p. 37, 1853; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 576, 1864.

Arcinella cornuta Conrad, Am. Journ. Conch., ii., p. 105, 1866.

Chama (*Echinochama*) *arcinella* Fischer, Man. de Conchyl., p. 1049, 1887.

Chama (*Arcinella*) *spinosa* H. and A. Adams, Gen. Rec. Moll., ii., p. 464, 1857.

Pliocene marls of the Caloosahatchie, Shell Creek, and Alligator Creek, south Florida, also at De Leon Springs (Wright) and Shoal River, Walton County, Florida, Burns; living from Cape Fear, North Carolina, to San Paulo, Brazil, and through the Antilles from near low-water mark to twenty-six fathoms.

This well-known species was described from a recent specimen with rather long spines by Linné. Its chief variations are in the length of the spines, their number being occasionally increased by intercalation, and in coloration. Those from Florida are usually white externally, frequently with a pink flush internally, while the Antillean specimens are usually more or less brown or ferru-

ginous outside. Orbigny states that the species is attached by its left valve, which is, of course, an error. I find no persistent differences between the recent and Pliocene shells. Those mentioned by Conrad, when he described *C. cornuta,* are not constant in a large series. Fifty-five specimens of the fossil forms show ribs ranging in number from seven to fourteen, averaging 9.6 ribs each. Forty specimens of the recent shell have from five to sixteen ribs each, and average 8.8. There is obviously nothing distinctive in the number of ribs, and I have not found anything among the other characters. The specimens of *E. californica* in the collection show twenty to twenty-one ribs, and are pure white with a yellowish tinge.

The shell figured by Holmes under the name of *C. arcinella* is the young of another species.

Superfamily CARDITACEA.

Family CARDITIDÆ.

This family is of ancient origin and is represented in the Mesozoic by several groups, but, as in other cases, only the Tertiary and recent forms will be considered here. The family is related to the *Crassatellitidæ, Astartidæ,* and *Chamidæ,* as a scrutiny of its paleontologic history, the anatomy, and the development of recent forms conclusively show.

The hinge has been compared to that of the *Veneridæ,* but in my opinion the resemblance is slight and superficial. The Venerid hinge has never less than three left cardinals, which show no traces of torsion, while the *Carditidæ* have never more than two, and the posterior one invariably long drawn out, a feature characteristic of the family. The most fully developed hinge is met with in such forms as *Carditamera,* which exhibits a hinge with the formula $\frac{\text{L. } 01.01010.01}{\text{R. } 10.10101.10}$, though the anterior and posterior right cardinals are in the adult shell almost obscured by the stem of the anterior right lateral and the nymph respectively, though quite recognizable in the young shells. The cardinals are almost invariably finely, transversely striated. In such forms as *Venericardia antiquata* Linné the formula is reduced to $\frac{\text{L. } 0.0101.0}{\text{R. } 0.1010.0}$ by degeneration. It is evident when such changes take place in the growth of the individual, and when certain of the teeth are or may be obsolete in the developed shell, that too much stress in classification should not be placed on these mutable features. In fact, the subdivisions of the principal genera must be based chiefly on form, the types of which, it must be acknowledged, are rather unexpectedly constant in the faunas following that of the early Eocene.

Throughout the family the tendency of the lunule is to be very small or

even absent, but the trace which exists is usually circumscribed by a deep sulcus, the termination of which on the left inner hinge-margin is usually marked by a little pustule. I was at first disposed to associate this prominence with the anterior left lateral, which often is superimposed upon it, but finding in several species both lateral and pustule present and not coincident, I concluded the latter simply represents the dynamic effect of the structure of the tissues which secrete the lunular margin.

The sulcus in *Beguina* has been so affected by the torsion-like manner in which the hinge has been drawn out and twisted that it actually has become tubular, though in life probably closed by an organic plug of some kind.

The escutcheon is frequently present, not bounded by a sulcus or other emphatic limit, but rather indicated by a more or less distinct carina.

In general the members of this family may be divided into elongate species which are usually byssiferous, and short or subtriangular forms in which there is no gape or byssus in the adult shell.

We know nothing of the characteristics of many of the recent animals of this group, but considering those of which we have information it appears that the species are dicœcious, and the females have a tendency to retain the young until a start has been made in growth beyond the prodissoconch stage. In the triangular forms, such as *Venericardia borealis* Conrad, the young in large numbers are incubated in the ovary or its atrium in the umbonal cavities of the valves. In some of the mytiloid species a marsupium is formed by the ventral margins of the mantle (*Thecalia, Milneria*), which secrete and line a shelly pouch on the ventral side of the valves in which the eggs are hatched, and the nepionic shells are for a time retained.

The prodissoconch is usually smooth and ovate, sometimes with the extreme margins thickened and projecting, while the nepionic sculpture of radial ribs commences suddenly.

The sculpture in this group is predominantly radial, usually strong; *Calyptogena* alone has no radial sculpture. The pallial line is almost invariably simple and entire; a broad scar, which may be connected with the siphonal sphincters, occurs in *Cardiocardita ajar*. The ligament and resilium are external.

The species seem to affect rocky or gravelly regions from low water to moderate depths, rarely exceeding one hundred fathoms except in a few cases, where shallow-water Arctic or boreal species follow the cold water southward into gradually increasing depths. The distribution is world-wide, the mytiloid forms being, however, restricted to the warmer seas.

The species of this family may be arranged under the following groups:

Subfamily **CARDITINÆ**

Marsupium seated in the soft parts, not reflected in the structure of the shell.

Mytiloid forms.

Genus *Cardita* (Bruguière, 1792) Lamarck, 1799. Type *Chama calyculata* Linné.

Valves elongate-quadrate, strongly radially ribbed, very inequilateral, with a slight ventral byssal gape.

Section *Cardita* s. s. Type *C. calyculata* Linné.

Hinge with two left and three right cardinals, the laterals obsolete in the adult; the inner margins of the valves usually fluted or serrate.

Section *Carditamera* Conrad, 1838. Type *C. arata* Conrad.

Valves with the laterals well developed in the adult, the right anterior cardinal often obsolete.

Section *Glans* Megerle, 1811. Type *C. trapezia* Linné.

Valves short, quadrate, convex; the posterior right cardinal often obsolete; the species usually small.

Subgenus *Beguina* Bolten, 1798. Type *Chama phrenetica* Born.

Shell large, mytiliform, subcompressed, with feeble radial sculpture, the umbones terminal, the hinge as it were drawn out and arcuate, the lunule tubular, the posterior cardinals much elongated, laterals absent.

Azarella Gray, 1854, is synonymous. This peculiar shell seems to stand alone, with no recent or fossil congener. It belongs to the Indo-Pacific fauna.

Cardioid forms.

Genus *Venericardia* Lamarck, 1801. Type *V. imbricata* Lamarck. Parisian Eocene.

Shell rounded-trigonal, strongly radially ribbed, the ribs frequently beaded, especially when young, the lunule minute and deep, the escutcheon linear, the internal margins crenate, the hinge with two transversely striated cardinals in the left and three in the right valve, the laterals absent or obsolete, a sublunular pustule sometimes present in the left valve. Eocene to recent.

Megacardita Sacco is probably synonymous, the form being slightly more quadrate and elongate.

Subgenus *Cardiocardita* Anton, 1839. Type *Cardita ajar* Bruguière.

Hinge normal, pallial line with a broad scar in the locality usually marked by a sinus in groups with a sinuate pallial line, shell veneriform.

Agaria Gray, 1847; *Actinobolus* Mörch, 1853; and *Azaria* Tryon, 1872, are synonymous.

Subgenus *Cossmannella* Mayer Eymar, 1897. Type *Cardita ægyptiaca* Fraas (sp.). Egyptian Eocene.

Shell elongate-oval, the cardinal teeth feeble, the ribs slender and distant, the pallial line simple.

Subgenus *Cardites* Link, 1807. Type *Cardita antiquata* Linné (sp.) = *C. sulcata* Bruguière.

Shell like *Venericardia* s. s., but the anterior right cardinal absent; the laterals obsolete. Recent.

Section *Cardites* Link s. s. (See above.)

Shell more or less colored; frequenting warm seas.

Section *Cyclocardia* Conrad, 1867. Type *Cardita borealis* Conrad. Pleistocene and recent.

Shell white, with a rude periostracum, the female incubating the nepionic young in the atrium of the ovary. Boreal and colder waters of the globe.

Subgenus *Pleuromeris* Conrad, 1867. Type *Cardita tridentata* Say. Miocene and recent.

Shell small, subtriangular, nearly equilateral, the hinge like *Venericardia* but the anterior and posterior right cardinals feeble, the left valve with feeble anterior and posterior laterals.

Subgenus *Pteromeris* Conrad, 1862. Type *Astarte perplana* Conrad. Oligocene and recent.

Shell small, high, the anterior end longer, with narrow umbones and radial ribbing, a well-marked lunule and escutcheon present, the hinge as in *Cardites*.

Subgenus *Miodontiscus* Dall, 1903 (new name) = *Miodon* Carpenter, 1864; not Sandberger, 1870, nor Duméril, 1859. Type *M. prolongatus* Cpr. Pliocene to recent.

Shell not unlike *Pteromeris*, which has the anterior right cardinal missing and no laterals, while *Miodontiscus* has the posterior right cardinal absent and a posterior right and anterior left lateral feebly developed.

Subgenus *Neocardia* Sowerby, 1892. Type *N. angulata* Sowerby. Recent. South Africa.

Hinge as in *Cardites,* except that long posterior laterals are present, with no anterior laterals; the cardinals are diminutive, the shell small and subquadrate.

Genus *Calyptogena* Dall, 1891. Type *C. pacifica* Dall. Pliocene and recent on the Pacific coast of North America.

Shell smooth or faintly concentrically striated, with a well-marked escutcheon but no lunule; the inner margins smooth; dental formula $\frac{\text{L. } 1010.10}{\text{R. } 0101.01}$, including an anterior lateral in each valve; the teeth become more or less obsolete in the adult, and in the young retain the link between laterals and cardinals, which in most bivalves is lost at a very early age.

Attention may be called here to the Mesozoic *Pachycardia* (*rugosa*) Hauer, 1857, from the Alpine Trias; to *Prorokia* Boehm, 1883, which I know only through Zittel's citation of the name and date, and to *Pseudocardia* Conrad, 1866, changed by him (on account of its similarity to *Pseudocardium* Gabb, 1865) to *Vetocardia* in 1868, which in 1872 was stated by him to be a misprint for *Vetericardia,* a group which has been involved in much confusion, but which was intended to include the Cretaceous forms referred to *Venericardia* by Orbigny and is typified by *Astarte crenalirata* Conrad from the Ripley, Alabama, horizon. All the above have been referred to this family. *Cabralia* (*Schmitzii*) Boehm, 1899, from the Miocene of the Salvegens Islands, Azores, has also been placed in the *Carditidæ,* though it obviously belongs in the *Veneridæ,* somewhere near *Venerupis,* if the author's figures may be relied on. The supposed absence of a pallial sinus, which led the author to place it in the *Carditidæ,* is paralleled in some species of *Chione* and other exceptional *Veneridæ.*

Subfamily THECALIINÆ.

Marsupium in the ventral portion of the mantle, in the female, and protected by an infolding or indentation of the valves of the shell.

Genus *Thecalia* H. and A. Adams, 1857. Type *Cardita concamerata* Bruguière. Recent in South Africa.

Hinge with two cardinals in each valve, the posterior right cardinal absent, the middle one of the same valve large and prolonged behind; there is an anterior lateral in each valve. The male is without the marsupial pouch, gapes

slightly for a byssus, and resembles a species of the section *Glans*. Gray in 1854 referred the genus to *Mytilicardia*. When the valves are closed the shelly infold of the female is completely included within them. It is formed from the inner layer of the shell alone, and is lined by a fold of the mantle. The eggs are discharged into it and remain until the young shells have progressed beyond the prodissoconch stage.

Genus *Milneria* Dall, 1881. Type *Ceropsis minima* Dall, 1871. Recent. California.

Shell with two left and three right cardinals, the posterior left lateral, posterior and anterior right cardinals minute and hardly recognizable except in very well-developed specimens, in which the formula is $\frac{\text{L. 1.01010.}}{\text{R. 0.10101.}}$. The female has a dome-like indentation rising from the ventral margin of the valves, which is closed only by an extension of the mantle edge and therefore not included within the shut valves. The animal is minute, byssiferous, and a nestler on flat surfaces, like the backs of the shells of *Haliotis*.

The name *Ceropsis* being preoccupied in *Coleoptera* by Solier in 1839, it was replaced by *Milneria*. The young appear to be incubated in the same manner as in *Thecalia*.

Genus **CARDITA** (Bruguière) Lamarck.

Chama (sp.) Linné, Syst. Nat., ed. x., p. 691, 1758.

Trapezium (sp.) anonymous, Cat. Calonnianum, p. 50, 1797.

Corbula (sp.) Bolten, Mus. Bolt., p. 185, 1798; not of Bruguière.

<Cardita Bruguière, Enc. Méth., i., p. 401, 1792.

Cardita Lamarck, Prodrome d'un Nouv. Class. Coq., p. 86, 1799; sole ex. *C. calyculata* Bruguière.

Arcinella (pars) Oken, Lehrb. d. Naturg., pp. viii., 236, 238, 1815; not of Schumacher, 1817.

Cardita β Schumacher, Essai, p. 141, 1817.

Les mytilicardes Blainville, Dict. Sci. Nat., xxxii., p. 326, 1824; Mörch, Cat. Yoldi, ii., p. 38, 1853 (in syn.).

Mytilicardita Anton, Verzeichn., p. 10, 1839; Mörch, Cat. Yoldi, ii., p. 38, 1853.

Jesonia Gray, Synops. Brit. Mus., 1840; P. Z. S., 1847, p. 194.

Mytilicardia Herrmannsen, Index Generum Mal., ii., p. 83, 1847; Gray, Ann. Mag. N. Hist., xiv., p. 22, 1854 (*ex parte*); Tryon, Proc. Acad. Nat. Sci. Phila., p. 255, 1872.

Mytilocardia Agassiz, Nomenclator, p. 704, 1847.

Jesonia Philippi, Handbuch d. Mal., p. 462, 1853.

Not *Cardita* Mörch, Cat. Yoldi, ii., p. 38, 1853, = *Isocardia* Lam.

Section *Carditamera* Conrad.

Carditamera Conrad, Fos. Medial Tert., p. 11, 1838; type *Cypricardia arata* Conrad, 1832; Proc. Acad. Nat. Sci. Phila., xii., p. 231, 1861; xiv., p. 578, 1863.

Lazaria Gray, Ann. Mag. N. Hist., xiv., p. 22, 1854; type *L. radiata* Reeve; H. and A. Adams, Gen. Rec. Moll., ii., p. 489, 1857; Carpenter, Suppl. Rep. Brit. Assoc., p. 643, 1864.

Lazariella Sacco, Bolletino Mus. dei Zoologia, Torino, xiv., No. 349; Moll. Piem. e Liguria, p. 112, 1899. Type *Cardita subalpina* Mich.

Section *Glans* Megerle von Mühlfeld.

Glans Megerle, Entwurf, p. 68, 1811; type *Cardita trapezia* Linné (sp.); Mörch, Cat. Yoldi, ii., p. 38, 1853; Tryon, Struct. and Syst. Conch., iii., p. 257, 1872.

Subgenus BEGUINA Bolten.

Beguina Bolten, Mus. Bolt., p. 160, 1798; type *Chama phrenetica* Born; Mus. Bolt. zweite ausg., p. 112, 1819.

Beguina Mörch, Cat. Yoldi, ii., p. 38, 1853; Tryon, Struct. and Syst. Conch., iii., p. 257, 1872.

Azarella Gray, Ann. Mag. Nat. Hist., xiv., p. 22, 1854.

The earliest species which resembles *Cardita* s. s. in our Tertiary, but which may really be a *Carditamera,* is *C. subquadrata* Conrad, 1848, from the Eocene of the Orangeburg district. This is not the *subquadrata* Gabb, later renamed *perantiqua* by Conrad. These South Carolinian Eocene species have been poorly figured and inadequately described. They are probably of the lower Claibornian horizon, though this requires further investigation. *C. macropleura* Conrad, at first supposed to be from the Eocene of Virginia, was described under a misapprehension in 1869 and withdrawn later by the author.

These erroneous references being disposed of, we find the known species of *Carditamera* beginning in the Oligocene.

Cardita (Carditamera) tegea n. sp.

Plate 11, Figure 4.

Cardita (Carditamera) recta Dall, Trans. Wagner Inst., iii., part i., p. 189, pl. xi., fig. 4, 1890; not of Conrad, 1868.

Oligocene silex beds of Ballast Point, Tampa Bay, Florida; of Alum Bluff, Chattahoochee River, and of the Chipola River, Calhoun County, Florida; Dall, Burns, and Shepard.

Shell elongate inequilateral, with low, rather anterior beaks and about sixteen strong radial more or less carinated and imbricated ribs, the anterior ribs

more distinctly and regularly crenulate, the posterior more irregular; the interspaces about as wide as the ribs, and on the anterior half of the shell squarely channelled; posterior end of the shell produced and pointed, anterior end rounded, base mesially slightly concave; lunule small, deeply impressed, the anterior lateral tooth very prominent; hinge-teeth normal, rather slender; inner margins of the valves deeply fluted. Length 43, height 24, diameter 22 mm. The beaks are situated at about the anterior sixth of the shell.

The original figure of this species in Part I. was taken from a silicious pseudomorph which perhaps had been derived from a specimen which had been somewhat worn before being fossilized. Though certainly identical with the Chipola specimens from which the description is written the sculpture is less well preserved and smoother.

Cardita (Carditamera) Guppyi Dall.

PLATE 56, FIGURE 3.

Cardita minima "Sow." Guppy, Geol. Mag., dec. ii., vol. i., p. 18, 1867; not of Reuss, Böhm. Kreidef., ii., p. 14, pl. xxxiii., fig. 14, 1844.

Pliocene of Matura, Trinidad, also recent; *fide* Guppy.

I am unable to find any *Cardita minima* of Sowerby in the literature, and, at any rate, the name is preoccupied. Guppy's types are of small size, with about fourteen rounded ribs, separated by narrower interspaces, and more or less crenulated. The hinge is normal, the form trapezoid, and the beaks inconspicuous. The larger specimens are about 4 mm. in length and 3 in height.

Cardita (Carditamera) recta Conrad.

Carditamera recta Conrad, Am. Journ. Conch., iv., p. 279, pl. xx., fig. 2, 1868.

Miocene of Charles County, Maryland; Cope.

This appears to be a good species, notable for its elongation, straight form, and very anterior beaks. It has about sixteen ribs; the hinge is delicate and the teeth very slender.

Cardita (Carditamera) arata Conrad.

Cypricardia arata Conrad, Fos. Sh. Tert. Form., i., p. 20, pl. v., fig. 1, 1832.

Carditamera arata Conrad, Fos. Medial Tert., p. 11, pl. vi., fig. 2, 1838; Proc. Acad. Nat. Sci. Phila., xiv., p. 579, 1863.

Carditamera carinata Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 305, 1843; Fos. Medial Tert., p. 65, pl. xxxvii., fig. 1, 1845; Proc. Acad. Nat. Sci. Phila., xiv., p. 579, 1863.

Cardita carinata Tuomey and Holmes, Pleioc. Fos. S. Car., p. 67, pl. xix., fig. 6, 1855; Emmons, Geol. Rep. N. Car., p. 302, 1858.

Cardita pseudacarinata Orbigny, Prodr. Pal., iii., p. 114, No. 2133, 1857.

Carditamera arata Meek, Checkl. Mioc. Fos. N. Am., p. 7, 1864; Heilprin, Trans. Wagner Inst., i., pp. 102, 103, 1886; Whitfield, Mioc. Moll. N. J., p. 57, pl. ix., figs. 5–6, 1886.

Carditamera aculeata Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 585. 1863; Am. Journ. Conch., ii., p. 73, pl. iv., fig. 5, 1866.

Miocene of Shiloh and Jericho, New Jersey; near Easton, Maryland; Petersburg, Coggins Point, and Grove Wharf, James River, Yorktown, York River, and other Miocene localities in Virginia; Natural Well and Magnolia, Duplin County, North Carolina; Darlington, South Carolina; sixteen miles southwest of Tallahassee, Coe's Mill, Liberty County, and on the Chipola River, Calhoun County, Florida; Pliocene of the Waccamaw district, South Carolina, and of the Caloosahatchie, Myakka River, Shell Creek, Alligator Creek, and De Leon Springs in Florida.

This is the most wide-spread and abundant species of our Miocene and Pliocene. The differences upon which Conrad founded his *C. carinata* are inconstant and the specific name is preoccupied, for which reason Orbigny substituted *pseudocarinata*. Neither name is needed. Under the name of *Cardita arata* Tuomey and Holmes figure what appears to be Conrad's *C. protracta*. Conrad's *C. aculeata* is merely the young of *C. arata*, which is always more blunt than the adult and sometimes quite expanded behind with the imbrications produced into small spines. Conrad's figure does not agree very closely with that of his type specimen given by Whitfield.

Cardita (Carditamera) protracta Conrad.

Carditamera protracta Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 305, 1843; Fos. Medial Tert., p. 65, pl. xxxvii., fig. 1, 1845; Proc. Acad. Nat. Sci. Phila., xiv., p. 579, 1863; Meek, Checkl. Mioc. Fos. N. Am., p. 7, 1864.

Cardita protracta Orbigny, Prodr. Pal., iii., p. 114, No. 2134, 1857.

?Cardita arata Tuomey and Holmes, Pleioc. Fos. S. Car., p. 65, pl. xix., figs. 4, 5, 1855; not of Conrad.

Miocene of Jones Wharf, Patuxent River, St. Mary's County, Maryland; Conrad, Harris, Burns.

This form is very close to *C. arata*, yet seems to have some distinguishing characters, and the name should, perhaps, be retained.

Cardita (Carditamera) Vaughani n. sp.

Plate 56, Figure 10.

Miocene of Jackson's Bluff and of the Chipola River, five miles below the County Bridge, formerly Bailey's Ferry; T. W. Vaughan.

Shell robust, solid, inequilateral, subovate, the beaks low and slightly prosogyrate, near the anterior fifth of the valve; lunule narrow, deeply impressed; sculpture of about fifteen broad, slightly rounded radial ribs separated by channelled interspaces and crossed by rather thick, elevated threads or elongated nodules, imbricated towards the beaks and less prominent near the posterior base; the interspaces are only concentrically striated; hinge well developed, the laterals prominent, the inner margins coarsely fluted. Length 40, height 27, diameter 18 mm.

This recalls *C. floridana* Conrad, but is larger, proportionally higher, and with fewer and much broader ribs.

Cardita (Carditamera) Prestoni n. sp.

Plate 53, Figure 14.

Miocene limestone of Preston's Sink, near Waldo, Alachua County, Florida; L. C. Johnson.

Shell large, heavy, subovate, with low beaks near the anterior sixth of the valve, with a strong and heavy hinge; sculpture of about six very broad ribs in the middle of the disk and eight or nine smaller ones distally; deep muscular impressions; margin very coarsely fluted. Length 60, height 35, diameter about 36 mm.

This species is only represented by an internal cast in a friable Miocene limestone, but it is so markedly different from any other Tertiary American species that it seemed inadvisable to ignore it. It seems to have been somewhat of the type of *C. Vaughani,* but much larger, more inflated, and with the ribs on the middle of the disk exceptionally wide.

Cardita (Carditamera) floridana Conrad.

Plate 56, Figure 11.

Carditamera floridana Conrad, Fos. Medial Tert., p. 12, 1838; Am. Journ. Sci., 2d Ser., ii., p. 393, 1846.

Cypricardia nodulosa Mighels, Proc. Bost. Soc. Nat. Hist., i., p. 188, 1844.

Cardita gibbosa Reeve, Conch. Icon., i., Mon. *Cardita,* pl. iv., fig. 21, 1843; Krebs, West India Marine Shells, p. 123, 1864.

Cardita floridana Dall, Bull. 37 U. S. Nat. Mus., p. 46, No. 178, 1889.

Pliocene of the Caloosahatchie beds, Florida; Pleistocene of North Creek, near Osprey, West Florida; recent from Cape Canaveral, Florida, to the Keys, the Gulf of Mexico, and south to Yucatan.

C. laticostata Sowerby, of the Pacific coast, is externally much like this species, but it has no lateral teeth.

Cardita (Carditamera) catharia n. sp.

Plate 56, Figure 1.

Pliocene marl of the Caloosahatchie River, Florida; Dall.

Shell small, thin, delicate, elongate inequilateral; the beaks low, situated at the anterior seventh of the valve; anterior end rounded, posterior attenuated and almost pointed below; posterior dorsal margin convex; basal margin straight or even slightly concave; lunule small, broad, deeply impressed; sculpture of twenty-three to twenty-five small, rounded, beaded, radial ribs, separated by narrower rather deep interspaces, the inner margin and much of the inner face of the disk fluted by or reflecting the external sculpture; hinge very delicate, the laterals conspicuous. Length 7.0, height 4.5, diameter 4.0 mm.

This little shell may grow larger than the specimens collected, but it is distinctly different from the young of the various known species of our Tertiary.

Genus **VENERICARDIA** Lamarck

Venericardia Lamarck, Systéme des An. s. Vert., p. 123, 1801. Types *V. imbricata* and *V. planicosta* Lamarck. Parisian Eocene.

Venericardia Blainville, Dict. des Sciences Nat., xxxii., p. 326, 1824 (*V. planicosta* Lam.); Man. de Mal., i., p. 541, 1825; Gray, P. Z. S., 1847, p. 193; Mörch, Cat. Yoldi, ii., p. 37, 1853; Fischer, Man., p. 1010, 1887 (*V. imbricata* Lam.).

Cardissa Oken, Lehrb. d. Naturg., iii., pp. viii., 232, 234, 1815; not of Megerle, 1811.

Megacardita Sacco, Moll. Piem. Lig., xxvii., p. 9, 1899 (*V. Jouanneti* Basterot).

Subgenus CARDIOCARDITA Anton.

Les Cardiacardites Blainville, Man. de Mal., i., p. 540, 1825, sole ex. *Cardita ajar*, Bruguière; Dict. Sci. Nat., xxxii., p. 326, 1824; sole ex. *Cypricardia guinaica* Lamarck.

<*Cardiacardita* Anton, Verz. Conch., p. 10, 1839 (includes *ajar*).

Agaria Gray, P. Z. S., 1847, p. 194; "*Chama agar*" (= err. typ. pro *ajar*); Philippi, Handb. Conch., p. 435, 1853; *Cardita ajar*.

Actinabalus Mörch, Yoldi Cat., ii., p. 37, 1853 (1st sp. *C. ajar*); H. and A. Adams, Gen. Rec. Moll., ii., p. 486, 1857; Tryon, Proc. Acad. Nat. Sci. Phila., p. 252, 1872; not of Sacco, Moll. Piem. e Lig., xxvii., p. 17, 1899 (*C. antiquata*).

<*Venericardia* Gray, Ann. Mag. N. Hist., xiv., p. 22, 1854.

Azaria Tryon, Proc. Acad. Nat. Sci. Phila. for 1872, p. 252, = *Agaria* Gray, em.

Subgenus COSSMANNELLA Mayer Eymar.

Cassmannella Mayer Eymar, Journ. de Conchyl., xliv., p. 367, 1897. Type *Cardium ægyptiaca* Fraas (1867), Journ. de Conchyl., xliv., pl. x., fig. 6.

Subgenus CARDITES Link.

Section *Cardites* s. s.

Cardites Link, Besch. Rostock Samml., p. 153, 1807; sole ex. *Chama antiquata* L. (= *C. sulcata* Bruguière + *C. Bruguièri* Rovereto).

Cardita Megerle, Entwurf, p. 67, 1811 (*C. antiquata*); not of Lamarck, 1799.

<*Arcinella* Oken, Lehrb. d. Naturg., pp. viii., 232, 234, 1815; not of Schumacher, 1817.

Cardita α Schumacher, Essai, p. 141, 1817.

Cardita Gray, Ann. Mag. N. Hist., xiv., p. 22, 1854.

Section *Cyclocardia* Conrad.

Arcturus (Humphrey MS.) Gray, Zool. Beechey's Voy., p. 152, 1839; Gould, Inv. Mass., p. 94, 1841; *Cardita borealis* Conrad; not *Arcturus* Cuvier, *Crustacea*, 1829.

Cyclocardia Conrad, Am. Journ. Conch., iii., p. 191, 1867; Morse, An. Rep. Peabody Acad., Salem, Mass., p. 76, 1869; Tryon, Proc. Acad. Nat. Sci. Phila. for 1872, p. 255; Struct. Syst. Conch., iii., p. 233, 1884; Fischer, Man., p. 1010, 1887 (*C. borealis* Conrad).

Scalaricardita Sacco, Moll. Piem. e Lig., xxvii., p. 22, 1899. Type *C. scalaris* Sowerby, Min. Conch., v., p. 146, pl. ccccxc., fig. 3, 1825.

Actinobolus Morse, Ann. Rep. Peabody Acad. Sci., Salem, Mass., p. 76, 1869; not of Mörch, 1853.

Subgenus PLEUROMERIS Conrad.

Pleuromeris Conrad, Am. Journ. Conch., iii., p. 12, 1867. Type *Cardita tridentata* Say, Proc. Acad. Nat. Sci. Phila. for 1872, p. 52; Fischer, Man., p. 1010, 1887.

Subgenus PTEROMERIS Conrad.

Pteromeris Conrad, Proc. Acad. Nat. Sci. for 1862, p. 578, 1863 (*Cardita abbreviata* and *C. radians* Conrad, 1841); not *Pteromeris* Conrad, Am. Journ. Conch., i., p. 9, 1865 (*Astarte minutissima* Lea).

Coripia de Gregorio, Bull. Soc. Mal. Ital., x., p. 153, 1885. Type *Cardita unidentata* Basterot = *C. corbis* Philippi, En. Moll. Siciliæ, i., p. 55, pl. iv., fig. 19, 1836, and Wood, Crag. Moll., Bivalves, p. 168, pl. xv., fig. 2, 1853.

Subgenus MIODONTISCUS Dall, n. nov.

Miodon Carpenter, Suppl. Rep. Brit. Assoc., p. 642, 1864; Ann. Mag. N. Hist., 3d Ser., xiv., p. 424, 1864. Type *M. prolongatus* Cpr., *loc. cit.;* Stearns, Proc. U. S. Nat. Mus., xiii., p. 217, pl. xvi., figs. 7, 9, 1890; not *Miodon* Sandberger, Land u. Sussw. Conch. der Vorwelt, p. 35, 1870, *Cyrena media* Sowerby, upper Jura. = *Miodontopsis* Dall, 1903. Not *Miodon* Duméril, Arch. Mus. d'hist. Nat., x., p. 206, 1859. (Rept.)

Subgenus NEOCARDIA Sowerby.

Neocardia Sowerby, Mar. Shells S. Africa, p. 63, 1892. Type *N. angulata* Sowerby, *loc. cit.*, pl. iii., fig. 66.

Venericardia planicosta Lamarck.

Venericardia planicosta Lamarck, Syst. des An. s. Vert., p. 123, 1801; G. Fischer, Mus. Demidoff, iii., p. 260, 1807; Lamarck, Ann. du Muséum, vii., p. 55, ix., pl. xxxi., fig. 10; Sowerby, Min. Conch., i., pl. l., 1814; Lamarck, An. s. Vert., v., p. 669, 1818; Deshayes, Coq. Fos. des envir. de Paris, i., p. 142, pl. xxiv., figs. 1–3, 1824; Defrance, Dict. Sci. Nat., lvii., p. 231, 1828; Bronn, Leth. geogn., ii., p. 946, pl. xxxviii., fig. 7, 1836; Cossmann, Cat. Illustré, ii., p. 90, 1887; Bull. Soc. Géol. de France, 4me Ser., i., p. 653, 1901.

Cardita planicosta Deshayes, Enc. Méth., Vers., ii., p. 198, 1830; Traité élém. Conch.,, i., pl. xxxii., figs. 1–3, 1842; Bronn, Index Pal., i., p. 227, 1848; Orbigny, Prodr. Pal., ii., p. 324, 1850; Morris, Cat. Brit. Fos., 2d ed., p. 191, 1854; Deshayes, An. s. Vert. bas. Paris., i., p. 756, 1858.

Eocene of northern France, of Belgium and England, but not of southern Europe.

In taking up the great Venericardias of this type belonging to our Tertiary it is convenient also to consider this extreme eastern offshoot of the original American stock, to many of the forms of which Lamarck's name has loosely been applied.

When Lamarck described the genus he cited two species, *V. imbricata* and the present one, without selecting a type. Blainville some years later named *V. planicosta* as an example of the genus, and it has been generally accepted as the type. It is, however, undeniable that the two species of Lamarck stand for two groups which are represented side by side in all the Eocene horizons and still have representatives in the recent fauna, though that represented by *V. planicosta* seems absent from the Oligocene, Miocene, and Pliocene of North America. Its recent analogue occurs only on the Pacific coast in tropical waters. The distinctions are chiefly those of form, the *imbricata* type being rounded rhomboidal and the *planicosta* type arcuate triangular. These distinctions seem hardly of sectional value, yet they have persisted since the Mesozoic and represent, as it were, in each case a niche in the fauna which each respectively is best adapted to fill. The name *Megacardita* Sacco, given to a rhomboid form which differs from the *imbricata* type only by the greater smoothness of its ribs (a specific character only), is available if anyone wishes to designate these differences by a distinctive name.

Owing to their abundance in varieties, individuals, and their wide distribution in America, the distribution of the fossil *planicosta* on those coasts towards which migration might be favored by ocean currents and not in the Mediterranean region, and the presence in American waters of the only living repre-

sentatives of the group, I am persuaded that America is the centre from which the group has been distributed. In the fossil state it is characteristic of the Eocene; it was named by Conrad "the finger-post of the Eocene," and it does not occur (except as a *fossile rémanié*) in Oligocene or later strata.

The correlation of the different horizons of our Eocene with those of France and western Europe is based, not on the presence of identical species, which (excluding the boreal fauna) is hardly to be expected, but on the arrival of the fauna as a whole at an analogous stage of evolution. As climate developed differences in different parts of the globe, the dynamic effect of these differences on the faunas exposed to them would make itself felt in differentiation of species. Therefore even if identical generic groups occur in widely separated Tertiary faunas we should expect to find parallel, not identical, groups of species. This is what in reality we do find, and also that each fauna, as a rule, is clearly genetically linked with its predecessor in the same region. Only in cases of an abrupt change of conditions, especially temperature, do we find a break in the genetic series such as is offered by the succession of the Chesapeake cold-water Miocene on our southeastern coast to the warm-water Oligocene which preceded it. In minor changes, however, we occasionally find a resistant molluscan type which persists with only minor modifications and spreads to the uttermost parts of the earth, as in Paleozoic times. In the Eocene the *V. planicosta* type is one of these; so is *V. imbricata* and *Natica crassatina* of Lamarck.

We find in our Eocene and that of the Paris basin the following parallel forms in this group:

America.	France.
V. alticostata,	*V. imbricata,*
V. ascia,	*V. planicosta,*
V. marylandica,	*V. pectuncularis,*
V. rotunda,	*V. acuticostata,*
V. tridentata,	*V. decussata.*

Allowing for differences of generic types, such parallels might be increased almost indefinitely, and it is this fact, and not the presence of identical species, which justifies the correlation of the different horizons.

The distinctions between the Parisian and the American shell passing under the same name were pointed out by Rogers in 1839,* who also fully illustrated

* Trans. Am. Phil. Soc., N. S., vi., p. 374, pl. xxix., figs. 2 a–c.

the latter. Lea, however, in 1833 had noticed that the Claibornian form differed at the very least varietally from that of Paris. In 1844 Conrad separated the lower Claibornian from that of the Claiborne sands by the name of *densata,* in 1865 he named a Maryland form variety *regia,* and about the same time Gabb separated a Californian form under the name of *Cardita Hornii,* which had been referred to *V. planicosta* by Conrad. Paleontologists generally, having regard to the variability of these shells, nevertheless continued to call them *V. planicosta,* and, lastly, M. Cossmann in the work above cited points out and illustrates anew the distinctions between the form from the Claiborne sands and that of Paris, and would adopt for the American species thus segregated the name of *densata,* given by Conrad to the dwarfed variety from the lower Claibornian or upper horizon of the Lisbon section.

In England a comparison of specimens by S. V. Wood in 1871 led to the separation from *V. planicosta* of two varieties, *laticardo* and *angusticardo,* and d'Archiac has segregated from the continental form a variety *suessoniensis.*

The name of *Venericardia planicosta* was first applied by Lamarck in his "Systéme des Animaux Sans Vertébres," 1801, with the diagnosis "Testa crassissima, costis planis," and a reference to Knorr, "Recueil des monumens . . . petrif.," etc., part ii., pl. xxiii., fig. 5, 1767. He states that it is a fossil of the environs of Paris, also found in Piedmont and near Florence. Knorr's shell is stated to be an Austrian fossil, and is undoubtedly a *Cardita, senso lato,* but not identical with the French fossil. So it is evident that Lamarck at first confused several species together in his notion of *V. planicosta,* and the latter in its modern sense will date from his full description and figure in the "Annales du Muséum" of 1807. Curiously enough, Lamarck's figure is closer to the American type than to the average Parisian shell, though the wider nymph and projecting anterior shoulder indicate its origin.

Sir Charles Lyell, after comparing a Virginian specimen from Coggins Point, on the James River, said it could not be distinguished from one of the common varieties of the European shell. Conrad in speaking of the Maryland shell says it has twenty-two ribs, but either he did not count the smaller ribs on the dorsal slopes or the figures are a misprint for thirty-two, for twenty-two can be counted on his figure, in which the slopes are invisible. Rogers mentions that specimens indistinguishable from the Parisian shell occur in Virginia, but not usually in the same bed with the form which he named *V. ascia.*

Most of the paleontologists who have treated of the American shell have regarded it as identical with the Parisian form, but this may be due to the less

severe scrutiny formerly given to such analogues. It becomes an interesting question to decide whether this view is the correct one to take at the present time.

The average French *V. planicosta* is readily separated from the average Claiborne specimen by the greater breadth of the umbonal part of the valve and the more rounded and convex dorsal slope, which carries with it a broader area on the vertical faces of the nymphs. The anterior margin in front of the lunule is also more prominent for a short distance. The other characters mentioned by M. Cossmann in his careful comparison are inconstant.

Yet while these averages as above noted show a difference, there are occasional American specimens which almost reproduce the French type, and the first Claibornian specimen I happened to pick up for comparison with some from Grignon fitted the opposite French valve almost exactly, except for a quarter-inch space in front of the lunule. If the French specimens had been collected in America no one would regard the differences as more than varietal. The number of ribs is practically the same (thirty to thirty-five) in both, and I can only lay to inaccurate counting the statements which allow twenty to twenty-five ribs for either form. Both vary in having the ribs obsolescent towards the base in the same way. A comparison of Figures 1 and 2 (*densata*) given by M. Cossmann shows nearly as great a discrepancy between them as between Figure 1 (*planicosta*) and Figure 2 (*densata*) in the matter of the elevation of the beaks.

There is, then, some excuse and, in fact, justification for the reference of the American shell to the Lamarckian name. The estimation of values in such cases is liable to a large personal equation, but it seems to me that historic and stratigraphical paleontology will be benefited by regarding the differences as of subspecific rather than specific value.

The references to the names which have been applied since that of Rogers are as follows:

Cardita densata Conrad, Proc. Acad. Nat. Sci. Phila., ii., p. 173, 1844; Journ. Acad. Nat. Sci. Phila., N. Ser. i., p. 130, pl. xiv., fig. 24, 1848; *Venericardia d.*, Am. Journ. Conch., i., p. 8, 1865. Lower Claiborne bluff.

Venericardia planicosta var. *regia* Conrad, Am. Journ. Conch., i., p. 8, 1865; *Venericardia regia* Conrad, Checkl. Eocene Fos. N. Am., p. 5, 1866. Eocene of Piscataway, Maryland.

Cardita Hornii Gabb, Pal. Cal., i., p. 174, pl. xxiv., fig. 157, 1864; ii., p. 187, pl. xxx., fig. 83*a*, 1868; Tejon Eocene of California. *Venericardia Hornii* Conrad, Checkl. Eocene Fos. N. Am., p. 5, 1866.

Cardita planicosta var. *angusticardo* S. V. Wood, Mon. Eoc. Biv. Engl., part iii., pl. xxi., fig. 5c, and expl. of plate, Jan., 1871. Bracklesham, England.

Cardita planicosta var. *laticordo* S. V. Wood, *op. cit.*, expl. pl. xxi., fig. 5d, 1871.

Venericardia suessoniensis D'Archiac, Descr. Géol. du dep. de l'Aisne, p. 272, *fide* Deshayes; Mém. Soc. Géol. de France, v., pp. 195, 272, 193, 1842, *fide* Bronn. = *Cardita planicosta* var. *minor* Deshayes, An. s. Vert. bas. Paris, i., p. 756, 1858 (unfigured).

In order to get a clear idea of the evolution of the American form it will be in order to take up the various horizons beginning with the lowest Eocene. This will not cover what may be termed the lateral divergencies, or variations of the type in a single horizon, which are often marked.

Midway Stage.—In the basal Eocene the fossils are badly preserved in an extremely hard matrix, so that it is difficult to be certain of minor characters. However, we have here a small form, less than fifty millimetres in height, which undoubtedly is the precursor of *V. planicosta.** This is the *V. Mooreana* Conrad, Am. Journ. Conch., iii., p. 190, 1867; Harris, Bull. Am. Pal., iv., p. 38, pl. iv., fig. 13, 1896.

Chickasawan or *Lignitic Stage.*—In this stage we have developed several well-marked varietal forms. First may be cited the *V. ascia* of Rogers already referred to from Virginia. Next comes the large, somewhat rostrate, variety, *regia* Conrad, † from the Eocene of Maryland, Gregg's and Bell's Landings, Alabama. It is usually notable for the depth of the narrow furrows between the ribs, and the Maryland specimens usually have the concentric striation more intense and irregular than in the typical *ascia.* Another very marked form is the variety *Hornii* Gabb, ‡ originally described from California but abundant at Wood's Bluff, Alabama, and especially at Lisbon Bluff in the succeeding stage. It is remarkable in having the furrows linear, the ribs arching over to them, and in the obsolescence of the ribs except on the umbones, where they are sometimes beaded and terraced. The variety *laticardo* Wood, described from the Bracklesham beds of England, is reproduced at Hatchetigbee Bluff, Alabama. It is the form δ of Harris (*op. cit.*). Lastly we have a small, compact form, the *V. ascia* in miniature, which was described from the lower Claiborne by Conrad as *densata,* a variety which reaches less than fifty milli-

* The other forms associated by Professor Harris with this as varieties of *V. planicosta* I regard as distinct species; *i.e., Smithii* Aldrich, and *perantiqua* Conrad.

† Harris, Bull. Am. Pal., ii., No. 9, p. (55) 247, as form β, pl. ix., figs. 1, 2, 1897.

‡ Harris, *op. cit.*, form γ, p. (55) 247, pl. x., figs. 1–4.

metres in height, while the typical *V. ascia* when adult is commonly eighty. This tends to intergrade with the variety *laticardo*.

Claibornian Stage.

Lower Claibornian Substage.—In this we find the varieties *densata* and *Hornii*.

Claiborne Sands.—Here we have the *V. ascia* with numerous mutations, including nearly typical *planicosta* occasionally.

Jacksonian Stage.—Here we have the Claibornian forms reproduced but usually less vigorous, smaller, and more compact. Except in these respects, which nevertheless give a local aspect to the Jacksonian shells, this horizon repeats the mutations of the Claibornian.

It may also be noted that several types forming distinct species seem to branch off from the *planicosta* stock in the Lignitic, yet so far I do not find these sustaining themselves beyond the stage in which they originate. Such are *V. marylandica* Clark and *V. potapacoënsis* Clark from the Nanjemoy and Fort Washington horizons. The former is the *V. planicosta,* form *a*, of Harris, *op. cit.,* but it is distinct and the analogue of *V. pectuncularis* of the Parisian Eocene and not of the *V. planicosta*. The latter, which is small, oblique, and peculiarly pinched off behind, does not appear to have any exact analogue in the European beds and has been obtained only in Maryland.

Venericardia alticostata Conrad.

Cardita alticostata Conrad, Am. Journ. Sci., 1st Ser., xxiii., p. 342, 1833; Morton's Synops. Org. Rem., App., p. 7, 1834. Claiborne sands.

Venericardia Sillimani Lea, Contr. Geol., p. 69, pl. ii., fig. 47, 1833. Claiborne sands.

Venericardia transversa Lea, Contr. Geol., p. 68, pl. ii., fig. 46, 1833.

Venericardia alticosta Conrad, Checkl. Eoc. Fos. N. Am., p. 5, 1866.

Eocene of the Claibornian and Jacksonian series in Alabama and Louisiana.

This form represents the finest development of the ancestral strain of *Venericardia* from which the *planicosta* type is a lateral offshoot. This is shown by the umbones of *planicosta,* which have the beaded or serrate and terraced ribs of the *alticosta* type which are lost with growth. I am compelled to differ with Professor Harris, who has united the Midwayan species with *alticosta*. On the contrary, it seems to me that *V. perantiqua* Conrad (*V. subquadrata* Gabb, not Conrad) is sufficiently distinct both in sculpture, size, and general appearance, though the Midwayan specimens are rarely well preserved.

It appears both in Texas, Alabama, and New Jersey in the oldest Eocene, and is associated with another allied species which will be described later. The *V. transversa* Lea of the Claibornian is a short variety in which the posterior ribs are particularly prominent. It nearly bridges the gap towards *V. rotunda* Lea of the same horizon. The relations of *rotunda* to *V. complexicosta* Aldrich, from the Wahtubbee Eocene of Alabama, appear close. *V. carolinensis* Conrad, from the Eocene of South Carolina, is imperfectly described from a doubtful fragment and may be identical with *V. alticostata*. It has not been figured. On the other hand, the *V. Blandingi* Conrad, from the South Carolinian Eocene, was described from a badly worn specimen obscurely figured and may be identical with Lea's *rotunda*. *V. subrotunda* Conrad is not unlikely to prove the young of *V. vigintinaria* Conrad described at the same time from the Claibornian horizon at Orangeburg, South Carolina, and itself an imperfectly constituted species.

Other imperfectly known species are *V. Brittoni* Whitfield, from the older Eocene of New Jersey, and *V. bilineata* Conrad, from South Carolina, the figure of which recalls *V. floridana* Conrad. *Cardita tetrica* Conrad, of Wailes' "Report on the Geology of Mississippi," is an absolutely nude name, as is his *Venericardia jacksonensis* of the Eocene Checklist (No. 716). Both names probably were intended to refer to the small *Venericardia* of the Jacksonian, which closely resembles *V. rotunda,* but is higher, with more prominent and elevated beaks, higher ribs, and very marked peripheral fluting. This is a quite recognizable form for which Harris has adopted the name *tetrica* and which he has also collected at Vince's Bluff, Arkansas. Still another form related to *rotunda,* from Cleveland County, Arkansas, near Cross-Roads Church, is *V. præcisa* Dall, to be referred to later. None of these has the terrace or elevated thread on each side of the rib which characterizes *V. complexicosta,* though occasional specimens, especially of *rotunda,* show a tendency to develop such lines, and they are found on the umbones of some of the Lisbon specimens of *V. planicosta* var. *Hornii*. *V. trapezium* Tuomey, from the Eocene of North Carolina, was insufficiently described half a century ago and has never been figured. The whereabouts of the type is not known to me.

Venericardia bulla n. sp.

Plate 56, Figures 13, 14.

Brown sandstone of the Midway horizon, east of the first small creek on the road to Bastrop, Texas, from Old Garfield in the Austin quadrangle; T. W. Vaughan, United States Geological Survey.

Shell subovate, very much inflated, inequilateral, the beaks nearly anterior, decurved, low; surface sculptured with about thirty subequal, rough riblets, separated by subequal channelled interspaces; the ribs are crossed by numerous, somewhat irregular emphatic lines of growth, between which they are more or less imbricate; the ribs are sometimes squarish and towards the base more rounded or even obsolete, closer and finer behind; the lunule is deep and small; the outline of the shell varies, some of the specimens being shorter and higher than others; the inner margin is sharply and closely crenulate. Length 32, height 30, diameter 32 mm.

The fossils of this horizon are poorly preserved, but no other species known from our Tertiary approaches this in inflation. The interior is inaccessible, but the specimens, such as they are, apparently abundant.

Venericardia greggiana n. sp.

Venericardia alticostata var. Harris, Bull. Am. Pal., ii., p. 247, pl. ii., fig. 1, 1897.
Cardita decusata Tuomey, 2d Biennial Rep. Ala., p. 271, 1858; not of Lamarck, 1807.

Lower bed at Gregg's Landing, Alabama, in the Chickasawan or Lignitic stage of the Eocene.

Shell large, but relatively thin, with high beaks, but the line of the inner margins suborbicular; the ribs are narrow and high, about thirty-four in number, flattish above and even overhanging a little laterally, with flat, dentiform imbrications *directed towards the umbones;* the interspaces are subequal or slightly narrower than the ribs and channelled. The ribs in the young shell are accompanied by a narrow, elevated riblet on each side, but the adult has the posterior riblet generally obsolete towards the ends of the shell, and both riblets obsolete in the middle of the disk below; the beaks are prosogyrate, the lunule small and convex, the hinge rather light, and the inner margin sharply crenulate. It reaches a maximum height of 55 mm. and a diameter of 36 mm.

This form is rarely well preserved, but the sculpture, when perfect, is a clue to differentiate it from any other of our Tertiary species. It has a general resemblance to *V. Smithi* Aldrich, but is without the rostration or the minor sculpture of that species.

Venericardia nasuta n. sp.

PLATE 53, FIGURE 9.

Eocene of Conecuh County, Alabama; L. C. Johnson.

Shell very inequilateral, elongate, solid, with large prosogyrate, nearly anterior beaks; anterior end short and rounded, posterior produced, decurved,

subrostrate, terminally rounded; sculpture of about twenty-five low, carinate, obscurely beaded radial ribs, of which the posterior ten are nearly simple, the others acccompanied, more or less distinctly, by smaller lateral threads, one on each side; basal margin slightly incurved, lunule small, hinge of *Venericardia*, inner margin crenulated rather deeply. Length 41, height 27, diameter 26 mm., the anterior end 6 mm. before the vertical of the beaks.

This form has much the outline of a *Cardita* but all the usual characters of *Venericardia*. Mr. Johnson labelled it as from the Midway horizon, but this may have been only a surmise, no outcrop of that horizon being mapped in the county, and no exact locality assigned to the type specimen.

Venericardia wilcoxensis n. sp.

PLATE 54, FIGURE 12.

Venericardia alticostata var. Harris, Bull. Am. Pal., i., p. 171, pl. iv., fig. 12, 1896; not of Conrad.

Upper clayey layers of the Midway stage of the Eocene in Wilcox County, Alabama, near Graveyard Hill.

Shell short, high, rounded, with full, prosogyrate beaks over a small, convex lunule at the anterior sixth; sculpture of thin, sharp, high, serrate or pustulose ribs separated by much wider roundly excavated interspaces; a few ribs on the posterior and anterior dorsal slopes are more prominently pustular than the rest; on the disk the short slopes of the serrations are on the umbonal side; there are about twenty-six ribs in all, which are usually, but not invariably, simple, one specimen out of ten collected may show parallel threads in the interspaces; the posterior end is very slightly subtruncate, the anterior evenly rounded; the hinge is solid and normal; the fluting of the inner margins is rather coarse. Length 36, height 34, diameter 30 mm.

Compared with the roundest *V. alticostata* in a large collection, this species is less elongate, has much higher beaks, thinner, sharper, and more elevated ribs; the attendant riblets in the variety *tripla*, which has them, are finer and sharper; the prominences of the sculpture are sharper and higher.

We have also received this species from Matthew's Landing, Nanafalia Bluff, and the Sepulga River, Alabama, all Midway horizons.

Venericardia simplex n. sp.

PLATE 56, FIGURE 12.

Chickasawan (or Lignitic) Eocene of Wood's Bluff, Clarke County, Alabama; Frank Burns.

Shell inequilateral, broad ovate, with small, rather low beaks; anterior end short, rounded, posterior longer, arcuate dorsally, broadly rounded behind; base gently arcuate; sculpture of about twenty-five simple, low, subequal ribs, separated by wider, shallow, unchannelled interspaces; lunule small, impressed; hinge normal, basal margin internally fluted. Length 17.5, height 14.0, diameter 9.0 mm.

At first glance this species recalls a very much worn young *alticostata,* but an examination shows the surface to be intact and the sculpture naturally as described.

Venericardia præcisa n. sp.

PLATE 56, FIGURES 7, 8.

Venericardia rotunda Lea var. Harris, Ann. Rep. Geol. Surv. Ark. for 1892, ii., p. 149, 1894.

Jacksonian Eocene of Cleveland County, Arkansas, at Station 2232, S. 32, T. 10, R. 11 W.; G. D. Harris.

Shell thick, small, rounded, with small, rather anterior not elevated beaks; sculptured with about thirty-four narrow, uniform, articulated ribs, with a T-rail section, separated by about equal V-shaped interspaces with no accompanying threads or riblets; the articulation of the ribs is close, even, fine, and squarely nodular, flat and polished above; the posterior slope has the nodules more elevated and longer with their short slopes ventrally directed; there are on the average three to five articular nodes in a millimetre's length of rib; lunule small, convex; beaks situated about the anterior third; hinge heavy, inner margins elaborately and deeply fluted. Length 13.0, height 12.5, diameter 8.5 mm.

This differs from *V. tetrica* in having lower and more compact ribbing, with the tops of the ribs flattened, widened, and polished. In *tetrica* the beaks are higher, more prominent, more anterior, and the sculpture more rasplike.

Venericardia carsonensis n. sp.

PLATE 56, FIGURE 9.

Carson's Creek and Red Bluff Eocene of Wayne County, Mississippi; Burns.

Shell somewhat squarish, rounded, moderately inflated, thin, with about nineteen to twenty-one very narrow, elevated radial ribs, separated by much wider interspaces; sculpture imbricate-nodulous, the nodules in perfect specimens becoming irregularly spinose in the posterior third of the shell; the nodules are not so close to each other as in *V. tetrica* and *V. præcisa* as a rule,

especially in the young; lunule small and impressed; the beaks are lower and the whole form less oblique than in *V. tetrica;* hinge normal, more delicate than in the other species mentioned. Length of a moderate-sized specimen 17.0, height 16.5, diameter 11.0 mm.

While the spinosity of the posterior ribs is frequently worn away in adult individuals it is quite noticeable in the younger perfect ones, and the relative sparseness of the ribs with their wide interspaces immediately distinguishes it from *V. tetrica* and other near allies. It reaches, judging by fragments, a length of twenty or twenty-two millimetres when fully grown.

Venericardia vicksburgiana n. sp.

Plate 56, Figure 6.

Vicksburgian, partly silicified, limestone at Martin Station, near Ocala, Marion County, Florida; Willcox.

Shell small, squarish, with small, high, very anterior beaks and about twenty-two to twenty-three rounded, subnodulous, radial ribs, separated by nearly equal, roundly excavated interspaces; the ribs are lower and thicker than in the species above described and the nodules rounded; lunule small and impressed; margin with moderately impressed fluting. Length 15.5, height 15.0, diameter 10.0 mm.

Until this was discovered, in the form of silicious pseudomorphs, no *Venericardia* of this type was known from the Vicksburgian. As the last of its race it is small and degenerate with the feebleness of the sculpture as an indication of senility.

Venericardia scabricostata Guppy.

Cardita scabricostata Guppy, Quart. Journ. Geol. Soc. London, xxii., p. 293, pl. xviii., fig. 10, 1866; Gabb, Geol. St. Domingo, p. 252, 1873.

Lower Oligocene of the Bowden beds, Jamaica, and of St. Domingo; Vendryes and Gabb.

This species is small and has about eighteen ribs. Another more elongate species, perhaps a *Cardita,* occurs in the Oligocene horizon of the island of Antigua, but my example of it is but poorly preserved.

Venericardia serricosta Heilprin.

Plate 38, Figure 9.

Cardita (Carditamera) serricosta Heilprin, Trans. Wagner Inst., i., p. 117, pl. xvi., fig. 64, 1887.

Cardita serricosta Dall, Trans. Wagner Inst., iii., part v., p. 1194, pl. xxxviii., fig. 9, 1900.

Oligocene silex beds of Ballast Point, Tampa Bay, Florida; Dall, Burns, Willcox, and Shepard. Also at Bailey's Mill Creek Sink, in Jefferson County, Florida.

This species is abundant in the locality referred to, where it is represented by silicious pseudomorphs often beautifully reproducing the most delicate sculpture of the original shell. The sculpture recalls that of *V. perantiqua,* but the lateral terraces of the ribs are less pronounced and often absent. The hinge is that of normal *Venericardia* and not of *Carditamera.*

The species of this group from the Midway to the Chattahoochee are as follows, a new though allied type of notably robust habit taking up the line in the superincumbent formations:

Oligocene	Bowden	*V. scabricostata.*
	Chattahoochee	*V. serricosta.*
	Vicksburgian	*V. vicksburgiana.*
Eocene	Red Bluff	*V. carsonensis.*
	Jacksonian	*V. tetrica.*
	(Cleveland County, Arkansas)	*V. præcisa.*
	Claibornian	*V. rotunda.*
	Chickasawan	*V. complexicosta.*
	Midwayan	*V. perantiqua.*

A species belonging in this group appears in the black shales of the Isthmus of Panama at Gatun, but the condition of my specimens is not good enough to warrant naming them.

Venericardia hadra n. sp.

PLATE 53, FIGURES 11, 13.

Oligocene of the Chipola horizon on the Chipola River and at Alum Bluff on the Chattahoochee River, Calhoun County, Florida; Burns and Dall.

Shell solid, robust, obliquely oblong, the beaks full, prominent, prosogyrate, and nearly anterior; anterior side short, bluntly rounded, posterior side longer, compressed, roundly subtruncate behind; sculpture of about nineteen radial ribs, of which the posterior five or six are smaller and less elevated than the others; anterior ribs stout, sometimes with a thread or terrace laterally, the summit articulated rather sparsely with small, squarish, transverse nodules, which have a tendency to become obsolete behind and below; interspaces narrower than or subequal to the ribs, partially channelled; lunule extremely small

and deeply incised; hinge normal; the anterior cardinal pustular, the interior margins with shallow flutings. Length 47, height 38, diameter 36 mm.

A remarkably fine species, abundant in the Chipola beds, and not likely to be confounded with any but the following species:

Venericardia himerta n. sp.

PLATE 40, FIGURE 16; PLATE 53, FIGURE 12.

Cardita (sp.) Dall, Trans. Wagner Inst. Sci., iii., part v., p. 1196, pl. xl., fig. 16, 1900.

Oligocene of Oak Grove, Santa Rosa County, Florida; Burns.

Shell robust, large, convex, with full, prosogyrate beaks which completely conceal the lunule and are situated at the anterior fourth of the valve; hinge-line horizontal, the dorsal margin slightly arched over it, the anterior end produced near the hinge-line, rounded, and then curved obliquely towards the lower posterior end of the valve; posterior end very bluntly rounded, almost at right angles to the hinge-line; sculpture of about twenty strong, broad, slightly rounded, flattish ribs, crossed by narrow, sharp, low imbrications with their short slopes on the dorsal side, separated by somewhat narrower channelled interspaces, the whole crossed by rather irregular, coarse, concentric striations; in the young the ribs are relatively narrower, higher, and more regularly and distantly imbricate; hinge normal, the hinge-plate narrower than in *V. hadra,* the inner margins heavily and deeply fluted. Length 53, height 46, diameter 37 mm.

This fine species externally has a good deal the look of *V. hadra,* but on looking at the inner face of an adult valve we see that the beaks in the latter are more anterior, the hinge-line broader and more arched, the lunule exposed, and the outline of the disk, omitting the beaks, is nearly a regular oval, while in *V. himerta* the form is more nearly rounded trigonal, more abrupt behind and more produced just in front of the beaks. The latter species also attains a larger size.

Section *Cyclocardia* Conrad.

The species of this section, on the whole, occupy in the cooler seas the place taken in warmer waters by the preceding group. It is therefore not surprising to find them abundant in the cool Miocene waters from which the others have vanished. I have a fragment from the Vicksburgian Guallava beds of Costa Rica which may have belonged to a *Cyclocardia,* but, on the whole, I think it more probable that it belongs to some form of the previous series.

Venericardia (Cyclocardia) granulata Say.

Venericardia granulata Say, Journ. Acad. Nat. Sci. Phila., iv., p. 142, pl. xii., fig. 1, 1824.
Cardita granulata Conrad, Fos. Medial Tert., p. 12, pl. vii., fig. 1, 1838; Proc. Nat. Inst., Bull. ii., p. 187, 1842; Am. Journ. Sci., 2d Ser., i., p. 404, 1846; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 66, pl. xix., figs. 6–7, 1858; Whitfield, Mio. Moll. N. Jer., p. 56, pl. ix., figs. 1–4, 1894.
Actinobolus granulata Conrad, Proc. Acad. Nat. Sci Phila. for 1862, p. 578, 1863.
Cardita tridentata Emmons, Geol. Rep. N. Car., p. 302, fig. 236A, 1858; not of Say.
Venericardia (Cardiocardites) granulata Meek, Checkl. Mio. Fos. N. Am., p. 7, 1864.

Miocene of Atlantic City, New Jersey; of Plum Point, Maryland; of Petersburg, York River, Coggins Point and City Point, James River, Virginia; Wilmington, Murfreesboro', Magnolia, and the Natural Well, Duplin County, North Carolina; of the Ashley River beds, South Carolina; of Alum Bluff and Jackson Bluff, Florida; Pliocene of Sumter and the Waccamaw River, South Carolina.

This well-known and abundant Miocene species has been by Verrill and others united with *V. borealis* Conrad, a recent shell. It is certainly quite similar to, and doubtless the precursor of, *V. borealis,* but the careful study of a large series of both species leads me to believe that they are sufficiently distinct. *V. granulata* is constantly smaller, more ventricose, and less oblique, with fewer ribs, though the number varies in *borealis* from fifteen to twenty-one. In both species the ribs near the beak tend to be granulose or beaded.

Venericardia (Cyclocardia) californica n. sp.

Plate 56, Figure 16.

Pliocene(?) of California, five miles southwest of Guadalupe; G. H. Eldridge.

Shell of moderate size, rounded-trigonal, somewhat inequilateral; beaks small, prosogyrate, dorsal slopes steep, the anterior shorter, base arcuate; sculpture of fourteen to sixteen radial, more or less beaded or nodulous stout ribs, those on the posterior slope smaller, smoother, and less distant; interspaces channelled, subequal to the ribs; the whole with transverse concentric, somewhat irregular elevated lines. All the sculpture more feeble towards the base; lunule small, lanceolate, smooth; hinge normal, interior basal margin with a few coarse crenulations. Length 24.0, height 21.5, diameter 14.0 mm.

This coarsely ribbed subtrigonal species is clearly distinct from any other of our species, recent or fossil.

Other fossil species of this group are *V.* (*C.*) *castrana* Glenn, from the

Miocene of Reeds, Maryland; *V.* (*C.*) *monilicosta* Gabb, from the Pliocene of Santa Barbara, California; and possibly *V. inflatior* Meyer, if that is not the young of some Eocene species. I have no authoritative information of the finding of *V. borealis* fossil except in the latest Pleistocene of Labrador, and Point Shirley, Massachusetts.

Venericardia monilicosta Gabb was erroneously referred to Texas by Conrad in his Eocene list of 1865.

Cardita occidentalis Conrad, 1855, from Santa Barbara, California, may well be identical with *V. monilicosta,* but I have not seen the type and the description and figure are inadequate. *C. ventricosa* Gould is a recent species, wrongly confused with some of the fossil forms; *Cardita subtenta* Conrad (in Wilkes' Exploring Expedition, Geology) is similarly in doubt. All these were at one time unwisely lumped together under the name of *V. borealis* by Gabb and others.

Subgenus **PLEUROMERIS** Conrad.

Venericardia (Pleuromeris) parva Lea.

Venericardia parva Lea, Contr. Geol., p. 70, pl. ii., fig. 49, 1833; Conrad, Am. Journ. Conch., i., p. 8, 1865; Checkl. Eoc. Fos. N. Am., p. 5, 1866.

Cardita (*Venericardia*) *transversa,* mut. *juvenis* Gregorio, Mon. Claib., p. 213, pl. xxxi., figs. 14–22, 1890.

Claibornian and Jacksonian Eocene of Mississippi, Louisiana, Alabama, and Arkansas.

This small species is not typical of the subgenus, but has the lateral teeth which separate it from *Venericardia* and apparently foreshadows the subdivision, which does not appear in typical form until the Jacksonian. Gregorio has apparently taken this species for the young of *V. alticostata* Conrad and has figured the true young of *V. rotunda* under the name of *parva,* and the young of *alticostata* under the name of mut. *secans* Gregorio, altogether a very complete muddle.

A variety (which may be called *symmetrica*) of this shell occurs both in the Claibornian and Jacksonian, but appears to be very rare. It resembles the ordinary form in every way except that the beaks are erect and central, the dorsal slopes similar, and the resulting form of the shell a very regular oval. At the first glance this seems very distinct.

Venericardia (Pleuromeris) tellia n. sp.

PLATE 56. FIGURE 2.

Oligocene of the Chipola beds on the Chipola River and Alum Bluff on the Chattahoochee River; Dall and Burns.

Shell small, solid, rounded or ovate, slightly inequilateral, with a lanceolate escutcheon and a subcordate, smooth, impressed lunule; sculpture of twelve or thirteen narrow, squarish, closely nodulous radial ribs separated by wider interspaces, faintly concentrically striated; beaks rather low, slightly prosogyrate, situated at the anterior third; hinge heavy, the laterals distinct; internal margins strongly fluted. Length 4.0, height 3.5, diameter 2.75 mm.

Exceptional specimens may reach a length of five millimetres, and some specimens are shorter and higher than others.

Venericardia (Pleuromeris) scitula n. sp.

Plate 56, Figure 15.

Uppermost Oligocene sands of Oak Grove, Santa Rosa County, Florida; Burns and Aldrich.

Shell small, much resembling the last species, but larger, more elevated, and triangular, with twelve to sixteen low, broad ribs with narrower interspaces, the ribs crossed by small, elevated, concentric threads or ridges, more prominent distally than in the middle of the disk, and nowhere very conspicuous; lunule and escutcheon smooth, large for the size of the shell, the ribs on the dorsal slopes smaller and feebler than those on the disk; beaks small, high, erect, nearly central. Length 5, height 5, diameter 4 mm.

While in many respects similar to the last species, the differences seem to authorize its separation specifically.

Venericardia (Pleuromeris) tridentata Say.

Venericardia tridentata Say, Journ. Acad. Nat. Sci. Phila., v., p. 216, 1826; Binney's Say, p. 124, pl. xl., figs. 1–5, 1858; Dall, Bull. 37 U. S. Nat. Mus., p. 46, No. 183, 1889.

Cardita tridentata Say, Am. Conch., iv., expl. pl. xl., figs. 1–5, 1832; Conrad, Fos. Medial Tert., p. 76, pl. xliii., fig. 11, 1845; Am. Journ. Sci., 2d Ser., i., p. 404, 1846; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 67, pl. xix., figs. 9, 10, 1855; Holmes, P.-Pleioc. Fos. S. Car., p. 31, pl. vi., fig. 8, 1858; not of Reeve, 1843.

Cardita abbreviata Emmons, Geol. Rep. N. Car., p. 302, fig. 236, 1858; not of Conrad, 1841.

Venericardia (Cardiocardites) tridentata Meek, Checkl. Miocene Fos. N. Am., p. 7, 1866.

Pleuromeris decemcostata Conrad, Am. Journ. Conch., iii., p. 12, 1867.

Actinobolus tridentata Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 578, 1863.

Miocene of Wilmington, Magnolia, and the Natural Well, Duplin County, North Carolina; Pliocene of the Waccamaw district, South Carolina; Coe's Mills, Liberty County, and the Caloosahatchie River, Florida; Pleistocene of Simmons Bluff, South Carolina, and the Florida coast in general; recent from

Cape Hatteras, North Carolina, southward to Florida and the Gulf of Mexico, in thirty-six to one hundred and twenty-four fathoms.

This species grows larger than any of the others and has from twelve to eighteen ribs. The name was first applied to the recent form, which does not appear ever to attain the size and coarseness of sculpture of the fossils, which for this and other reasons were separated by Conrad in 1867 as a distinct species under the name of *decemcostata*. I cannot satisfy myself that the differences are specific, but if the fossil be considered a variety it may retain Conrad's name, though the number of ribs is not constant.

Another much smaller Pliocene species was described by Gabb from the clays of Limon, Costa Rica, as *Cardita Conradiana*.

Subgenus PTEROMERIS Conrad.

Venericardia (Pteromeris) acaris n. sp.

Plate 56, Figure 4.

Oligocene of the Bowden marl, Jamaica; Henderson and Simpson.

Shell small, plump, inequilateral, the full but rather low beaks situated near the posterior third; anterior end longer, obliquely produced, rounded, posterior dorsal border descending much more steeply, subangular at the lower posterior termination; sculpture of about eighteen broad, flattened radial ribs separated by narrow sulci and crossed by small, arcuate, raised threads, convex dorsally, the ends of these threads projecting sometimes give a punctate effect to the sulci; there is a small, narrow lunule and escutcheon apparently quite smooth; hinge normal, the laterals distinct; the inner margins sharply crenulate, the ligament and resilium wholly external. Length 2.5, height 2.5, diameter 2.0 mm.

This little shell is hardly a typical *Pteromeris,* but is possessed of all the essential characters and may be regarded as the precursor of the group. The posterior beaks are very characteristic features as well as the distinct laterals. It is the earliest known and smallest of the species.

Venericardia (Pteromeris) perplana Conrad.

Cardita perplana Conrad, Am. Journ. Sci., xli., p. 347, pl. ii., fig. 16, 1841; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 68, pl. xix., fig. 11, 1856; Emmons, Geol. Rep. N. Car., p. 302, fig. 235, 1858.

Cardita abbreviata Conrad, Am. Journ. Sci., xli., p. 347, pl. ii., fig. 17, 1841; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 69, pl. xix., fig. 12, 1856.

Astarte abbreviata Conrad, Fos. Medial Tert., p. 77, pl. xliii., fig. 12, 1845.

Astarte radians Conrad, Fos. Medial Tert., p. 77, pl. xliii., fig. 13, 1845.
Astarte flabella Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 24, pl. i., fig. 3, 1846.
Actinobolus (*Pteromeris*) *abbreviata* Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 578, 1863.
Actinobolus (*Pteromeris*) *radians* Conrad, *loc. cit.*, p. 578, 1863.
Venericardia (*Pteromeris*) *abbreviata* Meek, Checkl. Miocene Fos. N. Am., p. 7, 1864.
Venericardia (*Pteromeris*) *radians* Meek, *loc. cit.*, p. 7.
Venericardia obliqua Bush, Trans. Conn. Acad., vi., p. 478, 1885.
Venericardia (*Pteromeris*) *perplana* Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 705, 1903.

Miocene of Magnolia and the Natural Well, Duplin County, North Carolina; Pliocene of the Waccamaw district, South Carolina, and of the Caloosahatchie and Shell Creek, Florida; Pleistocene of south Florida; recent from Cape Hatteras, North Carolina, southward to Florida and the Gulf of Mexico from near low water to fifty-four fathoms.

Variety *abbreviata* Conrad.

Miocene of the York River, Virginia; of Magnolia and the Natural Well, Duplin County, North Carolina; of Darlington, South Carolina; Pliocene of the Waccamaw district, South Carolina, and of Shell Creek, Florida.

Conrad after describing the Duplin County fossil as a *Cardita* transferred it to *Astarte,* and as there was an *Astarte perplana* already he changed the specific name to *radians.* A year later he named recent specimens from Tampa Bay *Astarte flabella.* A shorter, more feebly sculptured form from the Yorktown and Duplin Miocene he named *Cardita abbreviata.* This is the ruling form in the older beds but intergrades with typical *perplana,* which later gradually supplants it, and so far I have seen no specimens of the variety among the recent shells.

Genus **CALYPTOGENA** Dall.

Calyptogena Dall, Proc. U. S. Nat. Mus., xiv., p. 189, 1891; xvii., p. 713, 1895. Type *C. pacifica* Dall.

The characteristics of this genus have been elucidated under the summary of the family (p. 1410).

Calyptogena pacifica Dall.

Calyptogena pacifica Dall, Proc. U. S. Nat. Mus., xiv., p. 189, 1891; xvii., p. 713, pl. xxv., figs. 4, 5, 1895.

Pliocene of Los Angeles, California, Cooper; recent, in Clarence Strait,

southeastern Alaska, at a depth of three hundred and twenty-two fathoms, muddy bottom; bottom temperature 42.4° Fahr.

This peculiar shell was reported to exist in some Pliocene beds cut through in grading streets in Los Angeles in considerable numbers, but poorly preserved. Specimens were submitted to me by Dr. Cooper for examination and comparison with the types in 1893.

Family CONDYLOCARDIIDÆ.

This family was instituted by Bernard for some extremely minute bivalves, related to the *Carditidæ*, but which retain in the adult state the immaturity of hinge characters which characterizes the nepionic shells of *Cardita*, and, moreover, have the resilium sunken and centrally located between the valves. The prodissoconch in this group is of the usual size, but appears very prominent on account of the relatively small additions made to it in growth. As in *Cardita*, the margins have sometimes a projecting border externally, which, under magnification, appears quite prominent, but in the larger forms now added to the family is not especially noticeable.

The following groups comprise this family:

Genus *Erycinella* Conrad, 1845. Type *E. ovalis* Conrad. Fossil in the Miocene of Virginia and the Crag of Britain.

Shell small, oval, radially sculptured, with an external ligament and internal resilium situated between the cardinals, of which there are two in each valve; in the left valve the edges of the resiliary chondrophore are somewhat raised, so that when worn the valve appears to contain four cardinals, but I think these ridges are not of the nature of true teeth; in the right valve the posterior cardinal is stout, and triangular and feebly grooved; there is a feeble, elongate, posterior right and anterior left lateral which fits into a groove in the margin of the opposite valve; the inner margins of the valves are crenulated.

The *E. ovalis* of Wood, from the Crag beds of England, is not the same species as the one described by Conrad from the Yorktown Miocene of Virginia, as I have determined from an examination of typical specimens. In his description Wood has regarded the raised edges of the chondrophore as teeth. In this species the ligament is much reduced and is set in a small chink directly between the umbones, so that it is concealed (though not internal) when the two valves are united, thus being in marked contrast to that of *E. ovalis* Conrad, which is set on a well-defined lateral nymph.

Subgenus *Carditella* E. A. Smith, 1881. Type *C. pallida* Smith. Recent. Magellan Strait.

Shell minute, trigonal, radially sculptured, with two cardinals in each valve, of which the right posterior one is ill defined; the resilium is sunken above and behind the two cardinals, the ligament as in *Erycinella;* there is an anterior and posterior lateral in each valve; the ligament is feeble; dental formula, $\frac{\text{L. 01.0r101.01}}{\text{R. 10,1r010.10}}$.

Subgenus *Carditopsis* Smith, 1881. Type *C. flabellum* Reeve.

Shell like *Carditella,* but the ligament obsolete and the resilium sunken between the beaks much as in *Erycinella;* dental formula, $\frac{\text{L. 01.10110010.10}}{\text{R. 10.0101101.01}}$, the posterior left cardinal obscure.

I am indebted to Mr. E. A. Smith, of the British Museum, for sketches of the types of this and the preceding group which have enabled me to present their characters clearly. The little *Erycinella ovalis* of S. V. Wood (not of Conrad), from the Coralline Crag of Britain, stands almost exactly intermediate between *Carditella* and *Carditopsis.*

Genus *Condylocardia* Bernard, 1897. Type *C. pauliana* Bernard. Recent, St. Paul, Stewart Island, and St. Helena. Fossil in the Parisian Eocene.

Shell minute, with conspicuous prodissoconch, the hinge-teeth only partially emerging from the nepionic state, so that it is difficult to decide what portion of a continuous lamina shall be called cardinal and what part lateral. After experimenting with varous formulæ I conclude that the laminæ of the type species may be represented by $\frac{\text{L. 1.10r101.0}}{\text{R. 0.01r010.1}}$ and those of *C. australis* by $\frac{\text{L. 01 01r01.01}}{\text{R. 10.10r10.10}}$, *Erycinella* having the formula $\frac{\text{L. 0.10r01.1}}{\text{R. 1.01r10.0}}$, so that when we consider the very amorphous and undeveloped condition of the laminæ in *Condylocardia* the relationship and essential similarity of the apparently diverse hinges is tolerably plain; the internal margins are feebly crenate or plain; the form rounded or subtrigonal, the sculpture concentric or, more generally, radial. The animal is viviparous, another linkage to the *Carditidæ.*

This type has not yet been found fossil in the American Tertiaries.

Genus **ERYCINELLA** Conrad.

Erycinella Conrad, Fos. Medial Tert., p. 74, Jan., 1845; Proc. Acad. Nat. Sci. Phila. for 1863, p. 578, 1864; *ibid.* for 1864, p. 212.

Erycina Orbigny, Prodr. Pal., iii., p. 115, 1857.

Erycinella ovalis Conard.

PLATE 53, FIGURE 2.

Erycinella ovalis Conrad, Fos. Medial Tert., p. 74, pl. xlii., fig. 5, 1845; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; *ibid.*, xvi., p. 212, 1864; Meek, Checkl. Inv. Fossils, Miocene, N. Am., p. 7, 1864.

Erycina ovalis Orbigny, Prodrome Pal., iii., p. 115, 1857.

Not *Erycinella ovalis* S. V. Wood, Mon. Crag. Moll., p. 171, pl. xv., figs. 10a–10f, 1853 (=*E. pygmæa* S. Wood, Cat. Crag. Moll., 1840).

Miocene of the York River, Virginia, at Yorktown and various other localities above Yorktown on the banks of the river.

The small valves of this species are not uncommon in the locality mentioned, but are very frequently waterworn, so that to obtain a clear idea of the hinge it is best to find a pair with the valves united, in which the remains of the resilium will often be found preserved.

Subgenus CARDITOPSIS Smith.

Erycinella (Carditopsis) Bernardi n. sp.

PLATE 53, FIGURE 10.

Pliocene clays of Limon, Costa Rica; R. T. Hill.

Shell minute, inequilateral, moderately convex, subquadrate, white, with about fourteen strong, rounded, radial, beaded ribs separated by deep, narrower, channelled interspaces; the beak is about five-twelfths of the length from the anterior end, smooth, conspicuous, convex, the prodissoconch limited by a thin, sharp, elevated, concentric lamina; the anterior slope is direct or slightly convex, the posterior longer, concave, with a depressed area bounded by a somewhat imbricated rib, but there appears to be no definite lunule; the interior is polished, with the exterior sculpture reflected by riblike radial elevations; in the right valve there are two minute cardinals between which is the socket of the resilium; the anterior dorsal margin is grooved to receive a small lateral from the opposite valve, and the posterior margin, bevelled and prominent, probably received into a groove in the left valve; the posterior end is subtruncate with an angle at the end of the dorsal slope; the base arcuate and serrate by the external sculpture; muscular impressions obscure. Length 2.0, height 1.6, diameter 1.3 mm.

A single right valve of this little shell was obtained from the clay. It has essentially the hinge of *Carditopsis,* but differs from the other species by the raised rim of the prodissoconch, a feature recalling *Condylocardia,* which has,

however, a more larval type of hinge with a straight hinge-line and crenulate provinculum not unlike that of *Limæa*.

It is named in honor of the lamented F. Bernard, whose researches on the development of the bivalve hinge have been so fruitful.

Superfamily CYRENACEA.

Family CYRENIDÆ.

Hinge when fully developed having three cardinal teeth in each valve; in the fossil precursors some of these may be suppressed.

This family was called *Corbiculidæ* by Prime, and there is much to be said in favor of retaining his name, as *Corbicula* is the most prolific in species and has a larger number of allied groups than *Cyrena,* though the latter possesses the largest individuals, and Gray used the name *Cyrenidæ* in 1840.

This family is first differentiated in the Mesozoic and includes the following groups:

Genus *Cyrena* Lamarck, 1818.

Genus *Corbicula* Megerle, 1811.

Genus *Miodontopsis* Dall, 1903.

Valves subtrigonal, with two cardinals and two long, cross-striated laterals in each valve, the anterior and posterior laterals subequal; pallial line with a small sinus.

This is *Miodon* Sandberger,* 1870, not of Carpenter, 1865. The type is *Cyrena media* Sowerby, from the Upper Jurassic Purbeck beds.

Genus *Loxoptychodon* Sandberger, 1872. Type *Cyrena intermedia* Deshayes. Lower Eocene.

Valves subtrigonal, the anterior end shorter; right valve with three acute triangular cardinals, the middle one bifid; left valve with two, the larger one bifid; lateral teeth cross-striated, the anterior shorter; pallial line with a broad, shallow sinuosity; margins smooth.

Genus *Plesiastarte* Fischer, 1887. Type *P. crenulata* Deshayes, as *Cyrena.* Lower Parisian Eocene.

Shell small, subtrigonal, concentrically striated, with three cardinal teeth

*Land u. Süssw. Conch. d. Vorwelt, 1870–1875. I know these genera of Sandberger only from figures and descriptions.

in the left valve, the anterior continuous with a short anterior lateral; right valve with two cardinals, a short socket for the left anterior lateral, a long socket for the long cross-striated posterior lateral of the left valve; ligament external; pallial line hardly flexuous; inner margins of the valves minutely crenulated.

This is *Anomala* Cossmann, 1886, not of Hübner, 1816. The specimens I have examined, obtained from M. Cossmann, have the lateral teeth smooth, but it is possible that in older specimens they may be striated, as the manuals assert. All these fossil forms need rigorous scrutiny, as it is quite possible that the characters of the hinge, where the distal cardinals in the adult are liable to become obsolete, may have been misinterpreted. In the light of Bernard's researches it is possible to recognize the equivalent of a tooth which earlier would have attracted no attention. The present type, if adult, would seem to be rather closely allied to *Loxoptychodon*.

Genus *Ditypodon* Sandberger, 1875. Type *Cyrena Suessii* C. Mayer. Lower Pliocene of Italy.

Valves oval, the anterior end shorter; one stout cardinal in each valve; laterals smooth, the anterior short and stout, the posterior longer; the pallial line obtusely sinuous.

Genus *Donacopsis* Sandberger, 1872. Type *Cyrena acutangularis* Deshayes. Eocene

Valves donaciform, compressed, the posterior end shorter, the disk sometimes feebly radiated internally with a slightly crenulated margin; hinge with three small cardinals in each valve, the posterior left one obsolete, the anterior right one very feeble; the laterals feebly striated, the anterior much longer than the posterior; pallial line with a short, wide, triangular sinus.*

Genus *Villorita* Gray, 1833.

Genus *Batissa* Gray, 1853.

Genus *Egeria* Roissy, 1805.

While closely related, it seems more convenient to place *Sphærium* and *Corneocyclas* (= *Pisidium* Pfeiffer) in a separate family.

The normal number of cardinal teeth for the *Cyrenidæ* is three in each

* This diagnosis is drawn from specimens kindly furnished by M. Cossmann, and is corrected from those previously published.

valve; the cases where a less number is found are usually due to suppression, and in the young they appear, if not in the adult. I have not been able to study some of the fossil forms above enumerated and give their dental characters with all reserves.

I am at a loss to understand Bernard's reference to *Iphigenia,* in which he states that the dentition is identical with that of *Cyrena.** From the specimens I have seen I should consider the dentition of *Iphigenia* as characteristically donacoid except in the suppression of the laterals, but I have not seen any very minute examples of *Iphigenia.*

Genus **CYRENA** Lamarck.

Cyclas (sp.) Bruguière, Enc. Méth., i., pl. ccci., fig. 3, pl. cccii., fig. 4, 1798; Bosc, Hist. Nat. des Coq., iii., p. 36, 1802.

Cyclas B ** Blainville, Dict. Sci. Nat., xxxii., p. 336, 1824; Man. de Mal., i., p. 551, 1825.

<*Cyrena* Lamarck, An. s. Vert., v., p. 551 *bis,* 1818; no type indicated, but the series divided into two groups, of which the first = *Corbicula* Megerle, 1811, and the other contains *Astarte borealis* Schumacher, *Cyrena caroliniensis* (= *caroliniana* Bosc), *C. bengalensis* Lamarck, and *C. zeylanica* Lamarck (= *C. coaxans* Gmel.); Deshayes ed. An. s. Vert., vi., p. 271, 1835; Férussac, Tableau Syst., p. xliii., 1821; Deshayes, Enc. Méth., Vers., ii., p. 46, 1830.

Cyrène ** Blainville, Dict. Sci. Nat., xxxii., p. 336, 1824; Man. de Mal., i., p. 552, 1825; *C. zeylanica* Lam.

Cyrena (*ex parte*) Rang, Man. des Moll., p. 313, 1829.

Not *Cyrena* Schweigger, Handb. d. Naturg., p. 707, 1820 (= *Corbicula* + *Astarte* sp.), nor T. Brown, Zool. Textb., i., p. 451, 1833 (= *Corbicula*), nor Sowerby, Conch. Man., ed. ii., p. 135, fig. 113, 1842 (= *Corbicula*).

= *Cyrena* Sowerby, Genera of Shells, fasc. v., 1822; *C. sumatrensis* Sby.; Swainson, Malac., p. 370, fig. 119a, 1840.

Cyrena β, Bowdich, Elem. Conch., ii., p. 9, 1822; Anton, Verz. Conch., p. 13, 1839.

Venulites (sp.) Schlotheim, Petref. Deutschl., p. 195, 1820.

Cyrena Gray, P. Z. S., 1847, p. 184, *C. zeylanica* Lamarck; Philippi, Handb. d. Conch., p. 314, 1853; Gray, Ann. Mag. N. Hist., 2d Ser., xi., p. 39, 1853; Woodward, Man. Rec. Fos. Shells, p. 297, 1854; Deshayes, Cat. Conch. Brit. Mus., pp. 219, 241, 1854; Meek, Paleont. Upper Missouri, p. 157, 1876.

Geloina Gray, Synops. Brit. Mus., p. 75, 1844; *Cyrena zeylanica* Lam.

>*Geloina* Mörch, Journ. de Conchyl., ix., p. 348, 1861; for old-world species with minute pallial sinus, no type cited.

* Bull. Soc. Géol. de France, 3me Sér., xxiii., p. 124, 1895.

Cyanocyclas Bourguignat, Rev. et Mag. de Zool., 2me Sér., vi., p. 673, 1854, = *Cyrena* s. s. Not *Cyanocyclas* Férussac.

Cyrnea Deshayes, An. s. Vert. bas. de Paris, i., p. 484, 1858; err. typ. pro *Cyrena* Lam.

Section *Polymesoda* Rafinesque.

Cyclas (sp.) Bosc, Hist. Nat. Coq., iii., p. 35, 1802.

Corneocyclas (sp.) Férussac, Dict. Sci. Nat., xii., p. 278, 1818; Deshayes, Enc. Méth., ii., p. 36, 1830.

Polymesoda Rafinesque, Ann. Gen. des Sci. Phys., Bruxelles, 1820, p. 319, *Cyclas caroliniana* Bosc.

Polymeroda Rafinesque, *op. cit.*, p. 319 (err. typ.).

Polymesoda Mörch, Mal. Blätt., vii., p. 193, 1861; Journ. de Conchyl., ix., p. 348, 1861 (*Cyrena carolinensis* Hanley, = *C. caroliniana* Bosc); Pilsbry, Nautilus, xv., p. 48, 1901.

Leptosiphon Fischer, Ann. Lyc. Nat. Hist. N. Y., x., p. 195, 1872; *C. carolinensis* Hanley.

Cyprinella Gabb, Pal. Cal., i., p. 170, 1864; *C. tenuis* Gabb, Cretaceous, California. (Not *Cyprinella* Girard, 1856.)

Diodus Gabb, Pal. Cal., ii., p. 242, 1868. New name for *Cyprinella* Gabb non Girard.

Section *Pseudocyrena* Bourguignat.

<*Anomala* Deshayes, P. Z. S., 1854, p. 20; not *Anomala* Hübner, 1816; *Cyrena insignis* Deshayes, West Mexico.

<*Pseudocyrena* Bourguignat, Rev. et Mag. de Zool., 2me Sér., vi., p. 675, 1854; *Cyclas maritima* Orbigny.

<*Egeta* H. and A. Adams, Gen. Rec. Moll., ii., p. 651, 1858; Chenu, Man. de Conch., ii., p. 103, 1862; *Cyrena angulata* Deshayes; Meek, Inv. Fos. Upper Missouri, p. 157, 1876.

<*Cyrenocapsa* Fischer, Ann. Lyc. N. Hist. N. Y., x., p. 195, 1872; *Cyrena floridana* Conrad.

Section *Egetaria* Mörch.

<*Egetaria* Mörch, Mal. Blätt., vii., p. 194, 1861; *E. pullastra* Mörch, West Central America.

Section *Isodoma* Deshayes.

Isodoma Deshayes, Descr. des An. s. Vert. bas. de Paris, i., p. 481, 1858; *I. cyprinoides* Deshayes, Eocene; Cossmann, Cat. Illustr., i., p. 125, 1886.

Subgenus LEPTESTHES Meek.

Leptesthes Meek, Prel. Rep. Geol. Surv. Wyoming, p. 316, 1872; *Corbicula fracta* Meek, Eocene; U. S. Geol. Surv. Terr., 6th Ann. Rep., p. 512, 1873; Pal. Upper Missouri, p. 161, 1876.

The history of the genus *Cyrena* is as confused as that of some of the other groups of this family, and has required much study to elucidate. Species were included under *Cyclas* Bruguière until separated by Lamarck, who used the name in 1818 for a group of bivalves which he divided into two sections, α and β, the former mainly equivalent to *Corbicula* Megerle and the latter containing an *Astarte* and three species of *Cyrena* as later understood. No type was mentioned. Two years later Rafinesque made the first of Lamarck's Cyrenæ, *C. caroliniana* Bosc, the type of his subgenus *Polymesoda,* leaving *C. bengalensis* and *C. zeylanica,* one of which must be taken as type. The latter has been frequently used, but it conflicts with the restricted diagnosis requiring an unsinuated pallial line for the genus, and was in 1844 selected by Gray for the type of his genus *Geloina,* which has a minute pallial sinus and is confined to the Old World. In this sense *Geloina* was revived by Mörch in 1861, and therefore we must accept *Cyrena bengalensis* Lamarck, which is figured by Delessert as having an unsinuated pallial line, as the type of the genus. Many of the earlier writers used *Cyrena* in the sense of the prior *Corbicula,* which, of course, cannot be accepted. The number of species which belong to the restricted section without any indication of a pallial sinus appears to be quite small. Most of the Old-World species have a very minute and superficial impression near the adductor scar, which is due to the siphonal retractors, but which in a dead or worn specimen is hardly to be traced. The fossil precursors of *Cyrena* usually have an obvious though small sinus; and the species of the New World, except in the group of *Pseudocyrena,* have a narrow but deep and well-marked sinus. These differences taken alone are hardly generic, and intergrade pretty closely, as might be expected.

The siphons in *Cyrena* are separate and rather short; the branchial siphon carries some papillæ around the orifice, which in the anal siphon is simple or nearly so. The margins of the mantle are thin and smooth with an inner fold which is parallel to the external edge and finely papillose; the margins are free from below the anterior adductor to the siphonal septum. The branchiæ are large and well developed, united behind the foot to form an anal chamber, and finely reticulate. The foot and visceral mass offer nothing peculiar, except that there is no byssus or byssal groove.

The hinge is very uniform in the group, having two short left laterals which are received into sockets or between duplicate laterals in the right valve. The cardinals are bifid, prominent, and strong, except the anterior right and posterior left cardinals, which are small and entire. The laterals are usually rather distant from the cardinals and may be smooth or finely granulated or

very faintly striated, but are never sharply crenate, as in *Corbicula*. The ligament is external and short, usually rather prominent; the opposing surfaces of the conspicuous nymphs are sometimes granular or rough. The inner margins of the valves, sometimes feebly striated, are never crenate or fluted. The exterior is smooth or concentrically sculptured, the sculpture being usually of small, sometimes sharp-edged, waves. These are sometimes confined to the anterior half of the disk. There is a conspicuous brown or olivaceous periostracum, and the interior of the valves is porcellanous, white, or suffused with violet, salmon color, or pale orange. The lunule is sometimes indicated by an impressed space more polished than the rest of the surface, but rarely if ever circumscribed by an incised line; there is no defined escutcheon and rarely any distinct lunule.

Cyrena is said to occur as early as the Jurassic. The earliest typical forms I have seen are from the Cretaceous, and not lower than the middle of that epoch, but I have not been able to examine many fossil pretertiary species. All the earlier types appear to have a visible pallial sinus. I suspect *Corbicula* to be the older type of the two, as it is by far the most prolific both in types and species.

The group may be divided as follows:

Genus *Cyrena* Lamarck.

Subgenus *Cyrena* s. s. (see above for characters).

Section *Cyrena* s. s. Type *C. bengalensis* Lamarck.

Pallial line entire or only a little truncate below the posterior adductor scar; shell rounded-trigonal, plump, usually large. Oriental seas at the mouths of rivers, sometimes in permanently fresh water.

Section *Geloina* Gray. Type *C. coaxans* Gmelin (= *C. zeylanica* Lamarck).

Pallial line with a minute nearly obsolete sinus close to the adductor scar. Warmer regions of the Old World.

Section *Polymesoda* Rafinesque. Type *C. caroliniana* Bosc (= *C. carolinensis* Lamarck).

Pallial line with a deep, narrow sinus, otherwise like *Cyrena* s. s. In streams of America in the warmer regions.

Subgenus *Pscudocyrena* Bourguignat. Type *C. cubensis* Prime (+ *C. maritima* Orbigny, not C. B. Adams).

Shell small, thin, ovate or rostrate, inequilateral, the pallial sinus very

minute, the valves brightly colored, living in pure salt water. West Africa and the tropics of the New World.

?Section *Egetaria* Mörch. Type *C. pullastra* Mörch.

Shell tapetiform, radiately, minutely striated; the anterior laterals adjacent, the posterior laterals distant; the pallial sinus very deep, ascending. Pacific coast of Costa Rica.

I have not seen this species, which is unfigured.

Section *Isodoma* (Deshayes) Cossmann. Type *I. cyprinoides* Deshayes. Parisian Eocene.

Valves Cythereiform, thin, with delicate hinge and entire pallial line, the anterior end shorter, the laterals short, prominent, and smooth.

The dentition of this section was misunderstood by Deshayes, whose work has been corrected by Cossmann. It seems to bear to the oriental *Cyrena* such a relation as *Pseudocyrena* does to *Polymesoda*. I have not seen specimens.

Subgenus *Leptesthes* Meek. Type *Corbicula fracta* Meek. Eocene of the Wahsatch.

Shell large, solid, subrostrate, compressed, elongate-ovate; cardinals as in Cyrena, strong; anterior laterals subadjacent; posterior laterals distant, short, separated from the cardinals by a broad, flat hinge-plate; pallial line with a short, wide, triangular sinus; the lunule defined by an incised line; ligament elongated.

This appears nearer to *Cyrena* than to *Corbicula;* the short, low lateral laminæ are not crenate, and I do not find them even distinctly striated.

Diodus Gabb does not appear to differ essentially from *Polymesoda.*

According to White, in his discussion of our non-marine fossil Mollusca, two typical species of *Cyrena* appear in the Cretaceous of Dakota, *C. dakotensis* and *C. Carletoni* Meek, but there is nowhere any figure or description of the hinge or pallial line, and their allocation must remain doubtful until this is supplied.

Only one species of what appears to be a true *Cyrena* is known from our Tertiary, and as this is represented by silicious pseudomorphs which do not show the pallial line, even this may belong to the section *Polymesoda.*

Cyrena pompholyx Dall.

Plate 38, Figures 7, 8.

Cyrena pompholyx Dall, Trans. Wagner Inst., iii., pt. v., p. 1194, pl. xxxviii., figs. 7–8, 1900.

Oligocene silex beds at Ballast Point, Tampa Bay, Florida; Dall and Willcox.

Shell thin, obliquely trigonal, feebly, irregularly, concentrically striated; beaks high, full, somewhat prosogyrate, situated near the anterior fourth of the shell; anterior end short, rounded; posterior slope rapidly descending, long, the end of the shell subrostrate; one or two faint, shallow sulci extend from the beaks to the posterior extreme; a very small subcordate impressed area in front of the beaks may represent a lunule; hinge normal, the anterior right and posterior left cardinals slender, entire, the others larger and bifid; the anterior laterals short, low, adjacent, smooth; the posterior laterals longer and distant from the cardinals; nymphs rather long, their opposing surfaces smooth; muscular impressions small and rather high in the shell; pallial line obscure, but probably only slightly subtruncate behind and without a sinus; margins of the shell thin and smooth. Length 40, height 36, diameter 27 mm.

This species is rather peculiar in the thinness of its shell and the closely adjacent anterior lateral, but these characters do not appear to be more than specific, and are paralleled in some of the oriental forms and, especially the hinge character, in some of the European fossils.

Cyrena (Pseudocyrena) duplinĭana n. sp.

PLATE 56, FIGURE 22.

Upper Miocene of the Natural Well, Duplin County, North Carolina, and in the Pliocene of the Caloosahatchie beds, Caloosahatchie River and Shell Creek, Florida; Dall and Burns.

Shell small, thin, compressed, trigonal, subrostrate and acute behind, rounded in front; beaks subcentral, small, pointed; posterior slope direct, with a broad, low, rounded rib extending from the beak to the posterior extreme and limiting a slightly depressed posterior dorsal area; lunule not defined or impressed; basal margin arcuate; hinge-teeth small but clear-cut, laterals slender, the anterior rather long; nymphs short, smooth; pallial line with a small angular sinus. Length 8.5, height 7.5, diameter 5.0 mm.

This species may grow larger, though all the specimens found were small. They retain traces of purple coloration.

Cyrena (Pseudocyrena) floridana Conrad.

Cyrena floridana Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 23, pl. i., fig. 1, 1846; Prime, Mon. Am. Corbic., p. 28, fig. 21, 1865.

?Cyrena maritima Orbigny, Moll. Cubana, ii., p. 280, pl. xxi., figs. 47–50, 1853; not *C. maritima* C. B. Adams, Ann. N. Y. Lyceum N. Hist., v., p. 499, 1852.

?Cyrena cubensis Prime, Mon. Am. Corbic., p. 29, 1865.
Cyrena protexta Conrad, Am. Journ. Conch., v., p. 107, pl. xii., fig. 3, 1869.
Cyrena donaciformis Sowerby, Conch. Icon. Mon. *Cyrena*, pl. xix., fig. 108, 1878.
Not *Cyrena floridana* Sowerby, *op. cit.*, pl. xviii., fig. 102, 1878 (= *C. caroliniana* Bosc?).

Pleistocene of North Creek, near Osprey, West Florida, Willcox; living in salt water buried at the roots of sea grass from Tampa Bay south to the Florida Keys, Bahamas, and Cuba, and westward to Yucatan.

This species is variable in outline from subtrigonal to elongate and rostrate or even subovate. It is usually thin and with a delicate hinge, but occasionally under favorable circumstances becomes quite solid. It may be pure white, white streaked with violet, brownish, or wholly dark violet. I have not seen Cuban specimens and supposed that the heavier hinge illustrated on Orbigny's plate was a specific character, but I have since seen specimens quite as heavy which are undoubtedly varieties of *C. floridana*. I therefore conclude the two forms should be united. Conrad in one of his lapses of memory redescribed his own species under the name of *protexta*, while Sowerby figures what is probably *C. caroliniana* Bosc under the name of *floridana*, and redescribes the true *floridana* as *C. donaciformis*.

Cyrena (Polymesoda) caroliniana Bosc.

Cyclas caroliniana Bosc, Hist. Nat. des Coq., iii., p. 37, pl. xviii., fig. 4, 1802; Say, Am. Conch., vii., pl. lxii., 1833.
Cyrena caroliniensis Lamarck, An. s. Vert., v., p. 553.
Cyrena carolinensis Hanley, Rec. Shells, p. 93, pl. xiv., fig. 54, 1842.
Cyrena caroliniensis Holmes, Post-Pl. Fos. S. Car., p. 31, pl. vi., fig. 7, 1860.
Cyrena floridana Sowerby, Conch. Icon., 1878; not of Conrad, 1846.

Pleistocene of Simmons Bluff, South Carolina, and of North Creek, near Osprey, on the west coast of Florida; recent from South Carolina to Florida and westward to the coast of Texas, in streams and brackish water near the sea.

Subgenus LEPTESTHES Meek.

This group is chiefly lower Eocene and is numerous in the Wahsatch, Laramie, Judith River, and allied horizons in the west and in the Puget Group of the Pacific coast. The following species have been named: *C. (L.) fracta, subelliptica,* and *planumbona* by Meek; *C. (L.) brevidens* and *cardiniæformis* by White. *C. crassatelliformis* Meek and *macropistha* White, from their form, probably belong here.

Genus **CORBICULA** Megerle.

Cyclas (sp.) Lamarck, Syst. des An. s. Vert., p. 123, 1801, *C. euphratica* Lam.; Bosc, Hist. Nat. des Coq., iii., p. 35, 1802.

Corbicula Megerle von Mühlfeld, Entw. ein. Neues Syst., p. 56, 1811, *Tellina fluminalis* Müller; Rafinesque, Ann. Gen. des Sci. Phys., Bruxelles, 1820, p. 319, *C. fluviatilis* Müller, = *C. fluminalis* var.; Blainville, Dict. Sci. Nat., xxxii., p. 336, 1824; Man. Mal., i., p. 552, 1825; Gray, Ann. Mag. N. Hist., 2d Ser., xi., p. 38, 1853; Philippi, Handb. d. Conchyl., p. 314, 1853; Deshayes, Cat. Conch. Brit. Mus., ii., p. 219, 1854; Woodward, Man. Rec. Fos. Shells, p. 297, 1854; Meek, Inv. Fos. Upper Missouri, p. 160, 1876.

Cyanocyclas (sp.) Férussac, Dict. Sci. Nat., xii., p. 280, 1818.

Cyclas (*Cyrena*) sp., Schweigger, Handb. d. Naturg., p. 707, 1820, *C. fuscata*, = *Venus fluviatilis* Müller.

Cyrena α, Bowdich, Elem. Conch., ii., p. 9, 1822.

Cyclas B *, Blainville, Dict. Sci. Nat., xxxii., p. 33, 1824; Man. de Mal., i., p. 551, 1825.

Cyrena α, Anton, Verz. Conch., p. 13, 1839.

Cyrene Schlueter, Verz. Conch., p. 34, 1838, *C.* "*fulminea* Lam.," ? = *Cyrena* (*Corbicula*) *fluminea* Lamarck.

Cyrena T. Brown, Zoologists' Textb., i., p. 451, 1833, *C. fluminea* Lam.; Sowerby, Conch. Man., ed. ii., p. 135, fig. 113, 1842.

Corbulica Chenu, Man. de Conchyl., ii., p. 102, 1862; err. typ. pro *Carbicula*

< *Neocorbicula* Fischer, Man. de Conchyl., p. 1092, 1887, *C. variegata* Orbigny (= *C. limosa* Maton).

< *Veloritina* Meek, Prel. Rep. Geol. Surv. of Wyoming (Hayden), p. 294, 1872, *Corbicula Durkeei* Meek, upper Cretaceous; Sixth Ann. Rep. U. S. Geol. Surv. Terr., p. 511, 1873; Inv. Fos. Upper Missouri, p. 161, 1876; U. S. Geol. Surv., 40th Par., Paleontology, p. 167, 1876.

< *Cyrenocyclas* Agassiz, Nomencl. Zool., Index, p. 329, 1847; = *Cyanocyclas* corrig.

This genus is closely related to *Cyrena*, and the hinge is based on the same numerical elements, but the laterals are long and crenate or sharply cross-striated, and in the typical forms the pallial line is devoid of a sinus. Unlike *Cyrena*, all the Old-World species agree in having an entire pallial line. Most species of *Corbicula* are more or less concentrically sculptured and covered with a handsomely polished brown periostracum.

The following groups may be recognized:

Genus *Corbicula* Megerle.

Subgenus *Corbicula*.

Section *Corbicula* s. s. Type *C. fluminalis* (Müller).

Characters as above. Not viviparous?

Section *Veloritina* Meek, 1872. Type *C. Durkeei* Meek. Bear River Cretaceous of Wyoming.

Shell thick and solid, gibbous trigonal, the lunular and ligamentary areas deeply depressed; hinge with the cardinals as in *Cyrena* s. s., the left posterior cardinal obsolete in the adult; left posterior lateral formed by the bevelled edge of the valve, long, coarsely striated; anterior laterals short, adjacent, feebly striated; pallial line feebly flexuous.

Section *Corbiculina* Dall, 1903. Type *Corbicula Angasi* Prime, Journ. de Conchyl., xii., p. 151, pl. vii., fig. 6, 1864. Murray River, Australia.

Shell small, thin, elongate-oval, finely concentrically sulcate; nymphs short, their opposing surfaces granulate; hinge-teeth thin and delicate, laterals long, subequal, crenate; cardinals very oblique, otherwise as in *Corbicula;* pallial line entire.

This group has numerous species in India, Java, Madagascar, and Australia. *C. sikaræ* Ancey, from Madagascar, is viviparous, and the other species may be so.

Section *Tellinocyclas* Dall, 1903. Type *Cyrena tellinella* Deshayes, Coq. fos. bas. Paris., i., p. 123, pl. xix., figs. 18–19, 1824. Lower Eocene.

Shell small, solid, thick, inequilateral, the anterior end shorter, with low beaks, the valves narrow and elongate; the hinge as in *Corbicula* but the laterals straight and shorter, especially the anterior ones; the pallial line is entire, without flexuosity of any kind.

The shell figured by Sandberger under this name shows only two cardinal teeth in the right valve and a decided flexuosity in the pallial line and is referred by him to *Loxoptychodon.* The shell figured by Deshayes under the name of *Cyrena singularis* is externally similar but has a well-marked, rounded pallial sinus. The specimen before me has three cardinal teeth in each valve and a perfectly regular entire pallial line. Which is the *C. tellinella* of Férussac I am unable to determine, but the shell under observation appears to be that figured by Deshayes, and, owing to its remarkable form in such strong contrast to any other *Corbicula,* seems entitled to sectional rank.

Section *Cyrenodonax* Dall, 1903. Type *C. formosana* Dall.* Recent in Formosa, at the mouth of the Tamsui River; Hungerford.

Shell small, thin, delicate, donaciform, with three very oblique, slender cardinals in each valve, the middle one feebly bifid, the others nearly parallel with the hinge-line; the anterior end of the shell much longer than the posterior; the laterals elongate, slender, sharply crenate; the pallial line entire, the margins smooth.

This recalls *Donacopsis,* but is inflated, entirely without any sulcate radiation or crenulation of the valve-margin, has better developed teeth, and an entire pallial line.

Subgenus *Cyanocyclas* Férussac, 1818. Type *Corbicula limosa* Maton. American waters.

Shell resembling *Corbicula* but with a small, angular pallial sinus, the animal viviparous and confined to the streams of Central and South America and Mexico.

Férussac's genus included species of *Egeria* and *Corbicula* (both older names) and the single species of Maton, which must retain the name. *Neocorbicula* Fischer, 1887, is synonymous, and Agassiz, apparently not understanding the reference to the violet color in all these shells, altered the name to *Cyrenocyclas.*

It is somewhat remarkable that the only species of *Corbicula* known to our eastern Tertiaries should belong to the typical section, while all those of the western lake beds, from the Cretaceous to the Pliocene, as far as their characters have been recorded, belong to *Cyanocyclas.*

Corbicula densata Conrad.

Cyrena densata Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 324, 1843; Fos. Medial Tert., p. 68, pl. xxxix., fig. 2, 1845; Emmons, Geol. Rep. N. Car., p. 290, fig. 215*a*, 1858; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 77, pl. xx., fig. 1, 1858; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 576, 1863; Meek, S. I. Checkl. N. Am. Miocene Foss., p. 9, 1864; Prime, Mon. *Corbiculadæ,* p. 31, 1865.

"Near Petersburg, Va.," Tuomey; Pliocene of North Carolina, Emmons; of South Carolina, on the Waccamaw River, at Nixon's marl-pit, C. W. John-

* Shell plump, polished, with low but turgid beaks, covered with an olivaceous periostracum, sometimes with violet rays or with darker zones; the interior violet. The beaks at the posterior third. Length 12, height 8, diameter 6 mm.

son; and of Gay Head, Martha's Vineyard, Massachusetts, J. B. Woodworth.

This is a rare species with a perfectly regular unsinuated pallial line.

The section *Veloritina* Meek is represented by *C. nebrascensis* Meek and Hayden, from the Judith River beds; *C. occidentalis* Meek and Hayden, ditto; *C. Bannisteri* Meek, which is perhaps identical with *C. occidentalis,* and *C. cytheriformis* Meek and Hayden, also from the Judith River.

Cyanocyclas is represented by *C. umbonella* Meek and the following species: *C. Cleburni, C. obesa, C. Berthoudi,* and *Augheyi* of White. *C. intermedia* Meek and Hayden, *C. moreauensis* Meek and Hayden, and *C. subtrigonalis* Meek and Hayden; *C. californica* Gabb * (Pliocene, California); *C. pugetensis* and *C. Willisi* White (Puget Group) have not had their internal characters made out, but all the probabilities are in favor of their reference to *Cyanocyclas.* These are all from the brackish water beds of the West, originally referred to the "Laramie" except where otherwise stated. *C. cornelliana* Harris, 1897, from the Eocene of Hatchetigbee Bluff, is described from a fragment and must for the present remain in doubt as to its affiliations.

The brackish water Puget Group, which is widely extended on the northwest coast, contains many *Corbiculas,* and doubtless several yet undescribed. Its age is probably not uniform and the beds may represent a series extending from the upper Cretaceous to the Oligocene. It is a little odd that so prolific a fauna should have left no recent descendants, but none are found north of Mexico.

Genus VILLORITA Gray.

Villorita Gray, Griffith's Cuvier, Moll., p. 601, pl. xxxi., fig. 5, 1833. *Cyrena cyprinoides* Wood.

Cyrênodonte Joannis, Guerin's Mag. de Zool., 1836, tab. 70. Nude name, referred to *Villorita* Gray by Deshayes, Cat. Conch. Brit. Mus., ii., p. 240, 1854.

Villarita Eydoux, Guerin's Mag. de Zool., 1838, p. 11, pl. cxix., fig. 2, *Cyrena recurvata* Val., *fide* Eydoux, + *C. Gaudichaudi* Eydoux on plate; Dunker, Mon. Nordd. Weald., p. 29, 1846.

Villorita Philippi, Handb. der Conchyl., p. 315, 1853.

* Not *Cyrena californica* Prime, = *californiensis* Prime, + *C. subquadrata* Deshayes, 1854, not of Sowerby, Geol. Trans., 2d Ser., iv., p. 345, pl. xxi., fig. 8, 1836, Wealden. *C. californica* is erroneously stated by Prime to come from the State of California. It undoubtedly was obtained from one of the Mexican streams falling into the Gulf of California.

Velorita Gray, Synopsis Brit. Mus., pp. 75, 91, 1842, *fide* Gray; *ibid.*, 1844; P. Z. S., 1847, p. 184; Ann. Mag. Nat. Hist., 2d Ser., xi., p. 38, 1853; Deshayes, Cat. Conch. Brit. Mus., ii., p. 219, 1854.

The type of this genus is

Villorita cyprinoides (Wood).

Cyrena cyprinoides Gray, Ann. Phil., N. S., ix., p. 137, 1825; Wood, Ind. Test. Suppl., pl. ii., fig. 14, 1828.

Villorita cyprinoides Gray, Griffith's Cuvier, Moll., p. 601, pl. xxxi., fig. 5, 1833.

Velorita cyprinoides Gray, P. Z. S., 1847, p. 184; not *Cyrena cyprinoides* Quoy.

The name of this genus appears to have been formed by an arbitrary combination of letters, which does not admit of correction from the form first used by its author.

It is characterized in the recent type species by elevated and swollen beaks, concentric sculpture, a small, angular pallial sinus. The left cardinals and the anterior right cardinal are entire, the latter subpyramidal; the other two right cardinals are bifid. The left anterior lateral is adjacent, short, thick, and arcuate, entering a socket above the pustular right anterior lateral. The posterior lateral is more distant and elongate and is finely striated. There is no defined lunule or escutcheon. The dental formula is $\frac{\text{L. 010.101010.010}}{\text{R. 101.010101.101}}$. The species occur in Japan, Malacca, and Indo-China in rivers, and one has been asserted to inhabit Liberia. The hinge, so far as the laterals are concerned, recalls *Rangia,* with which it is compared by Bernard, but the relationship is that of a similar result produced by dynamic influences and not genetic, as *Rangia* is certainly Mactroid and very closely related to *Mulinea.*

A singular shell dredged out of the ship channel of Tampa Bay, in rock belonging to the horizon of the Oligocene silex beds of Ballast Point, appears to have the shell characters of *Villorita,* though, as in the case of our Tertiary *Batissa,* I doubt if there is any more intimate relation between the oriental species and the fossil than that both have been evolved from the Cyrenoid stock independently of each other in different quarters of the globe.

Villorita floridana Dall.

Plate 43, Figures 8, 13.

Velorita floridana Dall, Trans. Wagner Inst., iii., part v., p. 1199, pl. xliii., figs. 8, 13, 1900.

Shell large, heavy, elevated, plump, with high prosogyrate beaks and broad hinge-plate; surface concentrically striated; lunule and escutcheon not defined; hinge with one obscure and two large anterior cardinals, a distant pos-

terior lateral, short and smooth; a very short arcuate socket for an anterior adjacent lateral above a pustular tooth equivalent to the right lamina in the right valve. The interior is obscured by silicious rock. Length 65, height 70, diameter (double) 50 mm. Horizon as above described.

Genus **BATISSA** Gray.

Capsa (Anonymous) Mus. Calonnianum, p. 59, 1797, *Venus erosa* Solander, = *Cyrena Keraudreni* Lesson (= *Batissa* sp.?); not *Capsa* Bruguière, 1797.

Batissa Gray, Ann. Mag. N. Hist., 2d Ser., xi., p. 38, 1853; *B. tenebrosa* and *B. obesa* Hinds; Deshayes, Cat. Conch. Brit. Mus., ii., p. 219, 1854; Tryon, Struct. Syst. Conch., iii., p. 185, 1854; White, Bull. U. S. Geol. Surv. No. 51, p. 60, 1889.

Australia and the Indo-Chinese islands.

This genus is characterized by large size and heavy ovate shells, with a very prominent ligament and a violet or salmon tint of coloration. The pallial line is not sinuated; the lateral teeth are distant from the cardinals and feebly striated. They are in the left valve and are received by sockets or paired laminæ in the opposite valve. There are three cardinals in each valve, the middle ones bifid, the others entire; the posterior right cardinal is usually oblique and unusually elongated. The dental formula is $\frac{\text{L. 010.101010.010}}{\text{R. 101.010101.101}}$.

The characters are such as might diverge from *Corbicula* at any time, and I doubt if the species of the Pacific coast Eocene and those now living in the South Seas are connected by a common origin except in some such way.

Two species, *Batissa Newberryi* and *B. dubia* have been described by Dr. C. A. White from the Puget Group of Washington on the Pacific northwest coast, and further information in regard to them can be found in Bulletin No. 51 of the United States Geological Survey, above cited.

Genus **EGERIA** Roissy.

Galatea Bruguière, Enc. Méth., i., pl. ccl., figs. 1a–c. (*G. radiata* Lamarck), 1797.

Galathea Lamarck, Ann. du Mus., v., p. 431, 1803 (not *Galathea* Fabricius, 1793); Rang, Man. des Moll., p. 313, 1829; Cuvier, Règne, Anim., iii., p. 147, 1830; Deshayes, Enc. Méth., ii., p. 165, 1830.

Egeria Roissy, Sonnini's Buffon, vi., p. 324, pl. lxiv., fig. 5, 1805 (*G. radiata* Lam.); not Dumeril, 1806, nor *Ægeria* Fabricius, 1808; not *Egeria* Leach, 1815.

Trigona (sp.) Schumacher, Essai, p. 153, 1817; not *Trigona* Jurine, 1807.

<*Cyanocyclas* (sp.) Férussac, Dict. Sci. Nat., xii., p. 280, 1818 (includes *Egeria* and *Corbicula* sp.).

Potamophila Sowerby, Gen. Shells, fasc. iii., 1821; not *Potamophilus* Germ., 1811.

Megadesma Bowdich, Elem. Conch., ii., p. 8, figs. 21a–b, 1822; not *Megadesmus* Sowerby, 1839.

Cyclas C, Blainville, Dict. Sci. Nat., xxxii., p. 33, 1824; Man. de Mal., p. 551, 1825.

Galateola Fleming, Brit. Anim., p. 409, 1828. Nude name, referred to *Galatea* Bruguière by Herrmannsen, Ind. Gen. Malac., i., p. 338, 1846.

<*Cyrenocyclas* Agassiz, Nomencl. Zool., Index, p. 329, 1847; = *Cyanocyclas corrig.*

>*Fischeria* Bernardi, Mon. Galat., p. 47, 1860. *F. Delesserti* Bern.; not *Fischeria* Desvoidy, 1830.

The type of this genus is

Egeria paradoxa (Born).

Venus paradoxa Born, Test. Musei Vindob., p. 66, pl. iv., figs. 12–13, 1780.

Venus reclusa Chemnitz, Conch. Cab., vi., p. 326, pl. xxxi., figs. 327–9, 1782.

Venus hermaphrodita Gmelin, Syst. Nat., vi., p. 3278, No. 40, 1792.

Venus subviridis Gmelin, *op. cit.*, p. 3280, No. 55.

Galathea radiata Lamarck, Ann. du Mus., v., p. 430, pl. xxviii., 1803.

Donax variegata Perry, Conch., pl. lviii., fig. 1, 1811.

Rivers of West Africa on the Guinea coast.

This genus has been unfortunate in its nomenclature, nearly all the names applied to it being preoccupied or uncomfortably close to other valid names in spelling or pronunciation. In accordance with the rules I have adopted and followed in this memoir, I accept the name *Egeria* of Roissy for the genus, as it is prior to Dumeril's use of the same name. The soft parts of *Egeria* differ very little from those of the Cyrenas, the siphons being somewhat better developed. The valves are heavy and thick in most of the species, subtrigonal, and the hinge is very heavy and rudely, radiately striate or sulcate, obscuring the character of the dentition, the separate teeth being often more or less broken up by deep fissures. The dental formula is essentially $\frac{\text{L. } 0.\overset{\frown}{1}0\overset{\frown}{1}0\overset{\frown}{1}0.0}{\text{R. } 1.0\underset{\smile}{1}0\underset{\smile}{1}0\underset{\smile}{1}1.1}$. There are, as normally in all the *Cyrenidæ*, three cardinals in each valve, the two posterior of the right valve being united above and received into a Λ-shaped socket in the left valve, below which an isolated tooth projects and is received into a socket below the united teeth of the right valve. There are two rude sulcate laterals in the right valve received into an anterior and a posterior socket respectively in the opposite valve. The body cavity of the valves is relatively small, the margins entire, the pallial line with a moderate or small rounded sinus. In *E. concamerata* Duval a buttress rises behind the anterior adductor scar to support the hinge-plate. The periostracum is strong, of a brown or olivaceous color sometimes radiated with violet; the shell is whitish or violet, like other Cyrenacea.

The group may be arranged as follows:

Genus *Egeria* Roissy.

Section *Egeria* s. s. Type *E. paradoxa* Born.

The characters are recounted above in detail; the dentition is rude, the laterals small and short, the pallial sinus small, the shell large and heavy.

Section *Profischeria* Dall.* Type *Fischeria Delesserti* Bernardi. West Africa.

Shell small and relatively thin, the anterior and posterior right cardinals obsolete in the adult, the middle cardinal bifid; in the left valve the middle cardinal is obsolete, the two others bifid; the laterals are slender and elongated, the bevelled edges of the left valve fit into sockets above them: the pallial sinus is relatively larger.

This section differs from *Egeria* by characters which might be expected in a small and thin representative of a rude and large genus. The name *Fischeria* applied to it by Bernardi had been used in *Diptera* thirty years earlier.

The relation to *Iphigenia* Schumacher, of the *Donacidæ*, which appeared to some of the older writers, is superficial. No species are yet known from our Tertiaries.

Family SPHÆRIIDÆ.

Cardinal teeth not exceeding two in each valve, and exhibiting a cessation of development at an early stage.

Genus SPHÆRIUM Scopoli.

Sphærium Scopoli, Intr. ad Hist. Nat., p. 397, type *Tellina cornea* Linné; Gray, P. Z. S., 1847, p. 184, No. 555; Ann. Mag. N. Hist., 2d Ser., xi., p. 39; Prime, Mon. Am. *Corbiculadæ*, p. 32, 1865; Westerlund, Fauna Palæarct. reg., vii., p. 5, 1890.

Nux (Anonymous) Mus. Calonnianum, p. 59, 1797. *Tellina cornea* Linné.

Cyclas (sp.) Bruguière, Enc. Méth., 3me livr., pl. ccci., 1798.

Cyclas Lamarck, Prodrome, p. 84, 1799, *Tellina cornea* Linné; Bowdich, Elem. Conch., ii., p. 8, fig. 22, 1822, *C. rivicola;* Raug, Man. des Moll., p. 312, 1829; Deshayes, Enc. Méth., ii., p. 36, 1830; Schlueter, Verz. Conch., p. 34, 1838; not *Cyclas* (Bruguière) Link, 1807.

Cornea Megerle, Entw. ein. neues Syst., p. 56, 1811, *Tellina cornea* Linné (*Cornea communis* Megerle).

Amesoda Rafinesque, Ann. Gen. des Sci. Phys., Bruxelles, 1820, p. 319, *Cyclas similis* Say.

* This and the other names in Cyrenacea proposed by the present writer first appeared in Proc. Biol. Soc. of Washington, xvi., pp. 5–8, February 21, 1903.

Ameroda Rafinesque, *op. cit.*, p. 319; err. typ. pro *Amesoda*.

Cycladites Kruger, Urwelt, ii., p. 469, *Tellina cornea* Linné.

Pisum Bourguignat, Rev. et Mag. de Zool., 2me Sér., vi., p. 85, 1854, *Cyclas rivicola* Lam.; not *Pisum* Megerle, 1811, founded on a fossil brachiopod.

>*Sphæriastrum* Bourguignat, *op. cit.*, pp. 668, 669, 674; Mem. Soc. des Sci. de Bordeaux, i., pp. 162, 164, 1854; Westerlund, Fauna Palæarct. reg., vii., p. 6, 1890, *S. rivicola* Leach.

Corneola Clessin, in Westerlund, Fauna Palæarct. reg., vii., pp. 6, 8, 1890; not *Corneola* Held, 1837.

>*Cyrenastrum* Bourguignat, Rev. et Mag. de Zool., 2me Sér., vi., pp. 668, 674, 1854; Mem. Soc. des Sci. de Bordeaux, i., pp. 161, 163, 1854; *Sphærium solidum* Normand; Westerlund, Fauna Palæarct. reg., vii., p. 6, 1890.

>*Eupera* Bourguignat, Rev. et Mag. de Zool., 2me Sér., vi., pp. 84, 663, 675, 1854; *Pisidium Moquinianum* Bourg.; Westerlund, Fauna Palæarct. reg., vii., p. 40, 1890.

>*Limosina* Clessin, Mal. Blätt., xix., p. 160, 1872, *Sphærium bahiense* Spix and *S. modioliforme* Anton; = *Eupera* Bourguignat.

>*Musculium* Link, Beschr. Rostock Samml., p. 152, 1807 (*Tellina lacustris* Müller, = *Cyclas calyculata* Drap.).

>*Calyculina* Clessin, Mal. Blätt., xix., p. 159, 1872; Westerlund, Fauna Palæarct. reg., vii., pp. 5, 14, 1890 (= *Musculium* Link).

A revision of this family with definitions of the proposed new subdivisions was published in the "Proceedings of the Biological Society of Washington," volume xvi., February, 1903.

The genus *Sphærium* forms a very natural group, of which in America none is known earlier than the Laramie, nor in Europe than the lower Eocene. It is divisible into several well-marked groups. The hinge retains permanently a condition of immaturity in the development of the teeth which recalls that of the *Leptonacea*. The type is that of the *Cyrenidæ*, but the teeth cease developing before arriving at the stage corresponding to that of *Corbiculina*, which is nearest to *Sphærium* in its hinge characters. The edge of the mantle is modified behind to form two delicate siphonal tubes, which, however, never take on the muscular character of true siphons and are contractile rather than retractile. The pallial line therefore exhibits no sinus. The sculpture is concentric and seldom strong. The beaks sometimes exhibit the nepionic stage distinctly and sometimes not. The ligament is deep-set, in a groove whose upper edges nearly meet over it, in species of the typical section; in others, like *S. rivicola* Leach, there is a wider gap in which the upper surface of the ligament is visible. In none is the ligament absolutely occluded, and the differences are small and only of degree. The cardinal teeth also are essentially

similar in type in all the species, the differences seen are merely due to the state of development at which they became stationary, and the attitude towards one another of the nepionic laminæ. The average dental formula is $\frac{\text{L. 010.1010.010}}{\text{R. 101.0101.101}}$; the anterior left and posterior right cardinals are often bifid, especially in large species like *S. rivicola*. The species are all viviparous.

The genus may be divided into the following groups:

Subgenus *Sphærium* Scopoli, s. s.. Type *S. corneum* Linné.

The nepionic shell passing into the adult without any distinct demarcation; the anterior end shorter; the ligament subinternal; the two right cardinals widely divergent and coalescent at their adjacent or upper ends, thus apparently forming but one tooth, but which if it had continued in development would have separated into two; the widening of the ventral angle causes the Λ-shape to disappear; the nepionic shell (and consequently the beaks) is finely, concentrically striate or even nearly smooth and rather convex.

This group = *Sphæriastrum* II.*, of Bourguignat, and *Cyclas* (*Corneola*)†, of Westerlund.

Section *Cyrenastrum* Bourguignat. Type *S. solidum* Normand.

This section only differs from the preceding by having the laterals cross-striated. It is not more solid and heavy than several other species, and I am puzzled to explain why it has been kept as a separate section by all the authors who have written lately on this group. In examining a large number of specimens critically I have found very wide individual variation in most species of *Sphærium* in the form and prominence of the cardinal teeth, which may explain why the differential diagnoses of the books are to a marked extent not borne out by the shells themselves.*

Section *Sphæriastrum* Bourguignat. Type *S. rivicola* Leach.

Shell resembling *Sphærium* s. s. but more coarsely sculptured; nepionic shell polished, concentrically and radially minutely striated; beaks of the adult with a few shallow, wide, low undulations; ligament largely exposed; a simple and a bifid cardinal tooth in each valve, otherwise like *Sphærium* s. s.

This is the largest form of the group, and in it the development of the car-

* As, for instance, authentic specimens of *S. ovale* Fér. are placed by Bourguignat among the species with internal ligament, yet the ligament in most of my specimens is as much uncovered as in *C. rivicola*. The teeth are said not to be Λ-shaped and those of *S. corneum* are described as Λ-shaped, yet between some specimens of the two species there is no marked difference, while others have the teeth quite distinct in form.

dinal teeth has gone far enough to separate those of the right valve, which in the typical section remain united.

Subgenus *Musculium* Link. Type *S. lacustre* Müller (as *Tellina*).

Nepionic valves inflated, concentrically finely striated, marked off from the adult growth by a distinct sulcus; ligament partly covered; cardinal teeth minute, often obsolete, continuous in the right valve.

This group is usually called *Calyculina* Clessin. The prominence of the calyculate umbones varies in different species.

Sphærium occurs in most of the western freshwater Tertiaries, in the loess of the Mississippi Valley, and in Pleistocene marls over the whole continent, but the species have been little studied.

The earliest recorded species are from the upper Cretaceous or lower Eocene of the Laramie beds, from which Meek and Hayden have described *S. planum, S. recticardinale, S. formosum, S. subellipticum,* and *S. fragile.** From beds referred to the Miocene in Utah Meek has named *S. rugosum* and *S. idahoense.* From the loess of Iowa City, Iowa, Shimek has recorded *S. sulcatum* Lam., *S. solidulum* Prime, and *S. striatinum* Lam. From the marls of Huron County, Michigan, Bryant Walker enumerates *S. striatinum* Lam., *S. simile* Say, *S. securis* Prime, *S. rhomboideum* Say, *S. occidentale* Prime, *S. partumeium* Say, and *S. truncatum* Linsley. From near Milwaukee, Wisconsin, F. C. Baker has collected out of a Pleistocene marl *S. simile* Say and *S. rhomboideum* Say. The interglacial beds of the Don Valley near Toronto, Canada, yielded to Professor A. P. Coleman *S. rhomboideum, striatinum, sulcatum, solidulum,* and *simile.* These lists might be considerably added to if the literature of the Pleistocene should be exhaustively searched.

Notwithstanding the presence of *Sphærium* in the interglacial beds above noted, it has not, so far, appeared in the Alaskan Pleistocene marls or those of the Hudson Bay region, though *Anodonta* and *Corneocyclas* occur abundantly.

Subgenus *Eupera* Bourguignat. Type *Pisidium Moquinianum* Bourguignat.

Shell subrhomboidal, moderately inflated, thin, with the posterior side longer, the ligament partly exposed, the cardinal teeth feeble, reduced to a single pustular denticle in each valve; the laterals elongated, strong, double in the right, single in the left valve. *Limosina* Clessin is synonymous.

* Not *S. fragile* Clessin, in Westerlund, 1890, from near Vegesack, in North Germany, which may take the name of *S. tenellum.*

This group is confined to the tropics and is known from North Africa, South America, the West Indies, Florida, Mexico, Yucatan, Central America, and Panama. The nepionic shell is visible, but not conspicuous in most cases, and feebly differentiated from the disk. The animal has two siphons (*E. cubensis*), is viviparous, and has the habits of *Sphærium*, which it mainly replaces in the tropics, though I have a typical *Sphærium* from Uruguay and another from Costa Rica. The shells of this group are subject to the attacks of a parasitic infusorian (?) of a blackish color which attaches itself to the inner surface of the valve and is often overlaid by a layer of shell secreted by the irritated surface of the mantle, so as to appear like color markings due to the mollusk itself; but, when fresh, these black specks can be easily removed on the point of a pin and are of a fleshy consistency.

Genus **CORNEOCYCLAS** (Férussac).

Corneocyclas (*ex parte*) Férussac, Dict. Sci. Nat., xii., p. 278, 1818 (*Pisidium pusillum* Gmelin, *P. virginicum* Gmelin, and *P. amnicum* Müller).

<*Phymesoda* Rafinesque, Ann. Gen. des Sci. Phys., Bruxelles, 1820, p. 319, *Sphærium ovale* Férussac and *Pisidium virginicum* Gmelin.

Phymeroda Rafinesque, *op. cit.*, p. 319, err. typ. pro *Phymesoda* Rafinesque.

Pisidium C. Pfeiffer, Naturg. Conch., i., p. 123, 1821; *P. amnicum* Müller (as *obliquum* Pfr.), *P. obtusale* Pfr., and *C. fontinale* Pfr.

Pera Jenyns (in syn. as of Leach MS.), Mon. *Cyclas* and *Pisidium*, Cambridge Phil. Trans., 1832, p. 13; = *Pisidium* C. Pfeiffer.

Pisidium Schlueter, Verz. Conch., p. 34, 1838; Gray, Man. Land and Freshw. Sh. Brit. Ids., p. 264, 1857; Prime, Mon. Am. *Corbiculadæ*, p. 59. 1865; Westerlund, Fauna Palæarct. reg., vii., p. 18, 1890.

Galileja O. G. Costa, Corris. Zool., i., 1839, *fide* Philippi, Moll. Sicil., ii., p. 214, 1844, *G. tenebrosa* Costa, = *Pisidium pulchellum* Jenyns.

Pera Gray, Turton, Man. Land and Freshw. Sh. Brit. Ids., 2d ed., p. 282, 1840; *ibid.*, 3d ed., p. 264, 1857; P. Z. S., 1847, p. 185, *Pisidium amnicum* Müller; Bourguignat, Rev. et Mag. de Zool., 2me Sér., vi., pp. 84, 675, 1854.

Euglesia (Leach) Gray, Turton, Man. Land and Freshw. Sh. Brit. Ids., 2d ed., p. 282, 1840; *ibid.*, 3d ed., p. 264, 1857; P. Z. S., 1847, p. 185, *Pisidium amnicum* Müller.

Cordula Leach, Synops. Moll. Gt. Brit., p. 292, 1852, sole ex. *Pisidium amnicum* Müller; Gray, Turton, Man. Land and Freshw. Sh. Brit. Ids., p. 268, 1857.

Pisum Gray, Ann. Mag. N. Hist., 2d Ser., xi., p. 39, *Pisidium amnicum* Müller; not *Pisum* Megerle, 1811, founded on a brachiopod fossil.

Physemoda Prime, Mon. Am. *Corbiculadæ* (in syn.), p. 62, 1865, = err. typ. pro *Phymesoda* Raf.

>*Euglesa* Leach, Syn. Moll. Gt. Brit., p. 291, 1852; Clessin, Malak. Blätt., xviii., p. 189, 1871, *Pisidium pusillum* Gmelin; Westerlund, Fauna Palæarct. reg., vii., p. 36, 1890.

>*Cycladina* Clessin, Mal. Blätt., xviii., p. 189, 1871, *Pisidium pusillum* Gmelin, *P. obtusale* Pfr., and *P. nitidum* Jenyns.

>*Fluminina* Clessin, in Westerlund, Fauna Moll. Suecica, p. 532, 1873, *Pisidium amnicum* Müller; Westerlund, Fauna Palæarct. reg., vii., p. 18, 1890.

>*Rivulina* Clessin, in Westerlund, Fauna Moll. Suecica, p. 532, 1873, *Pisidium globulare* Clessin; Westerlund, Fauna Palæarct. reg., vii., p. 20, 1890.

>*Fossarina* Clessin, in Westerlund, Fauna Moll. Suecica, p. 532, 1873, *Pisidium Henslowianum* Shep.; Westerlund, Fauna Palæarct. reg., vii., p. 22, 1890; not *Fossarina* Adams, 1863.

Gallileja Westerlund, Fauna Palæarct. reg., vii., p. 18, 1890, in synonymy, err. typ. pro *Galileja* O. G. Costa.

Cyclas (sp.) Blainville, Dict. Sci. Nat., xxxii., p. 33, 1824; Man. de Mal., i., p. 551, 1825.

The nomenclature of this group has been treated carelessly by authors, the result of which is, unfortunately, that the generic name now in common use will have to be discarded for a prior one; in fact, there are two prior ones which have been passed over in defiance or neglect of the rules of nomenclature.

In 1818 Férussac divided the heterogeneous group which had been called the Cyclades into two subgenera, the first of which was *Corneocyclas*. He named no type, and his list of species contained five species of *Sphærium*, two species of *Cyrena*, and three of *Pisidium*. *Sphærium* and *Cyrena*, being prior, cannot receive the new name, which must therefore be reserved for the Pisidia. Of these there are the following species: *fontinalis* Drap. = *pusilla* Gmelin, *dubia* Say = *virginica* Gmelin, and *amnica* Müller. Of these *virginica* was named *Phymesoda* by Rafinesque in 1820; *amnica* was called *Pisidium* by C. Pfeiffer in 1821; leaving unappropriated *pusilla*, which must be taken as the type of the restricted genus *Corneocyclas*. All belong to one genus but may be available for the subdivisions into which that genus may be divided. Now *P. amnicum* Müller has usually been taken as the type of the genus *Pisidium* because it is the first of the three species cited in connection with the first description of the genus. But Pfeiffer gives in his diagnosis the specification that his genus has "an der rechten Schale ein, an der linken Schale zwei" cardinal teeth, therefore out of the three species he cites it is advisable, if one can be found, to take one which wholly agrees with his diagnosis, and *P. amnicum* has two teeth in each valve. It seems that the other two species do have the required character, therefore one of them should be utilized as type. Since *P. obtusale* is intimately related to *P. pusillum*, so that they will go in one

restricted group, which is already named by Férussac, we are thrown back upon *P. fontinale* C. Pfeiffer (not *Cyclas fontinalis* Drap.), which is practically in the same case, so we are obliged to follow what has been the common practice and accept *P. amnicum* as type, unless we are prepared to drop the name *Pisidium* altogether. Following up the other names, we find *Pera* (Leach MS.) Jenyns (in synonymy) to be an absolute synonym of *Corneocyclas*. *Euglesia* (Leach MS.) Gray, 1840 (in Turton), and Gray, 1847; *Pisum* Gray, 1847, *Cordula* Leach, 1852, and *Fluminina* Clessin, 1873, are all based on *Tellina amnica* Müller, and are therefore synonyms of *Pisidium* s. s. *Galileja* Costa and *Euglesa* (Leach, 1852) Clessin, 1873, are not to be separated from *Corneocyclas*. *Cycladina* Clessin, 1871, founded on *P. obtusale*, is identical. *Rivulina* Clessin was based on *P. globulare* Clessin (=*P. pusillum* Jeffreys, 1862, not Gmelin), which does not seem to be distinguished from *Pisidium* s. s. by any valid characters. *Fossarina* Clessin (*P. Henslowianum* Sheppard) is preoccupied in *Gastropoda* since 1863 by A. Adams. Having thus cleared the track of some obstructions, it remains to revise the classification, which has been of a mechanical and not a truly morphologic character hitherto. I have in this work accepted Westerlund's determination of the species, many of which, fortunately, are represented in the National Museum by author's specimens sent originally to Doctor Gwyn Jeffreys, and purchased with his collection. As the arrangement by Clessin, based on minor conchological features, must be rejected, and most of his groups are not only heterogeneous but absurd, his names must follow their typical species and, as we have seen, they will fall into synonymy.

There can be no doubt, I think, that the most fundamental characters in a group which is so uniform in externals, and which in hinge characters finds itself arrested before the nepionic characters are wholly lost, are those of the nepionic shell as preserved on the umbones of the adult, and in the present revision I shall adopt this hypothesis.

The nepionic shells of *Corneocyclas* present marked characters, enabling us to give clear definitions of the various groups. They may be simply convex and concentrically striated, passing without any strongly marked change of characters into the disk of the adult valve, or the stage when the change took place may be marked by a slight but evident sulcus, constriction, or line of limitation. In another group the nepionic valves are flat and exhibit one or two relatively broad, stout undulations, which, when the ventral edge of the nepionic valve and the undulation coincide, appears in profile as a raised edge or keel on the convexity of the disk. A third type has on the nepionic surface

a single raised radial keel which in profile appears like a spur or small, blade-like prominence. These characters are so obvious as to afford excellent data for grouping the various species in accordance with their genetic relations. It should not be forgotten that the Abbé Dupuy in 1843 suggested a classification of the *Sphæria* on a similar basis, which was met with undeserved scorn by Bourguignat, whose less scientific arrangement for the time prevailed.

The shell of *Corneocyclas* has the anterior end longer than the posterior, is concentrically feebly sculptured; there are no crenulations of the inner margins, and while the lunule and escutcheon are sometimes clearly defined by a delicate line they are hardly visible except under strong magnification and are lost by the slightest wear. The ligament, as in *Sphærium*, is inset, and in most cases only the narrowest chink, if any, exists above it between the edges of the valves. In a few species, notably *C. virginica* Gmelin, a portion of the ligament is external, but in most of them it may be fairly called internal. This is another larval character, the protoligament being situated between the valves; whence, in most pelecypods, it migrates upward; while in those forms in which it is called internal it has redescended, and not merely kept its original emplacement. But in the *Sphæriidæ* it is probable that it has never emerged from between the valves to a greater extent than we find it at present.

The hinge of *Corneocyclas* consists of paired laterals, anterior and posterior, in the right valve, and single ones in the left valve; these in the larger and more solid species often show a faint striation or granulation, but in the majority are smooth. The cardinals in the best developed forms have become independent of each other and of their lateral laminæ, and comprise two teeth in each valve, of which the posterior left and anterior right cardinals are slender and entire, the two others thick, subtriangular, and bifid. But in the great majority of the group, in which development has been arrested at an earlier stage of the hinge, the two right cardinals remain connected and are usually treated as a single sinuous or angular tooth, while the larger cardinal of the left valve remains of a hook-shape with more or less of its posterior limb attached, so that one cardinal appears below the other to some extent, instead of behind the other. In one small group of species traces of the connection between the original anterior lateral laminæ and the anterior cardinals still persist, as in *C. pusilla* Gmelin. In many cases the compound right cardinal becomes comma-shaped, with its thick posterior end bifid or clavate.

The foot is elongate and subconic, byssiferous in young stages; the mantle edges free except for the anal siphon, and there is no sinuation of the pallial line. All the species are viviparous.

The earliest American species is Cretaceous, but very little attention has been paid to the group in our Tertiary, though they exist in nearly all the freshwater Tertiaries of the west.

The group may be arranged as follows:

Genus *Corncocyclas* Férussac.

Subgenus *Corncocyclas*. Type *Tellina pusilla* Gmelin.

Nepionic shell convex, concentrically striated; hinge with two separate cardinals in the left, and a single compound, usually arcuate, cardinal in the right valve.

Section *Corncocyclas* s. s. Type *Tellina pusilla* Gmelin. Hamburg, Germany, type locality.

Nepionic valves passing into the mature disk without any strong demarcation; the anterior cardinal and lateral adjacent and retaining traces of their original connection; ligament internal.

Section *Phymesoda* Rafinesque. Type *Tellina virginica* Gmelin. Virginia.

Like *Corneocyclas* s. s., but the anterior laterals distant and unconnected with their respective cardinals; the ligament partly external.

Section *Pisidium* C. Pfeiffer. Type *Tellina amnica* Müller, 1774. Denmark.

The two right cardinals not consolidated, the larger cardinal in each valve bifid, the smaller one slender, entire; the laterals distant; the ligament internal.

Section *Cyclocalyx* Dall. Type *Pisidium Scholtzii* Clessin. Breslau, Germany.

Valves subconstricted near the junction of the nepionic shell with the disk, the umbones high and calyculate, otherwise like *Corneocyclas* s. s.

Subgenus *Cymatocyclas* Dall. Type *Pisidium compressum* Prime, 1851. Fresh Pond, Cambridge, Massachusetts.

Nepionic valves flat, transversely undulated, sharply delimited from the curved surface of the disk; hinge-teeth as in *Corneocyclas*, the cardinals feebly developed; ligament internal.

Subgenus *Tropidocyclas* Dall. Type *Pisidium Henslowianum* Sheppard. County Suffolk, England.

Nepionic valves with an oblique, elevated radial keel, and distinctly delimited from the curved portion of the disk; cardinals as in *Corneocyclas;*

ligament internal. *Fossarina* Clessin (*ex parte*), not of Adams, is synonymous.

Pisidium saginatum White, in Powell, "Geology of the Uinta Mountains," p. 128, 1876, and *P. contortum* Prime, "Annals Lyceum of Natural History of New York," vi., p. 65, pl. i., fig. 2, 1853, are the only two exclusively fossil species yet recorded from the United States. The former is from the upper Cretaceous lignite beds of Evanston, Utah, and the latter from the Pleistocene marl of Pittsfield, Massachusetts. A number of species have been reported from the loess and freshwater marls of the Mississippi Valley and Eastern States, which it is perhaps hardly worth while to enumerate here, but I may note that *P. virginicum* Gmelin is known from the marls of the Yukon Valley, Alaska, as well as from the existing fauna.

Superfamily ASTARTACEA.

Family CRASSATELLITIDÆ.

This group takes form in the upper Cretaceous. There are a number of names applied to genera or groups supposed to belong to this assembly of which material is not accessible to me sufficient to work out the origin and development of this family or the validity and accuracy of the characters upon which these minor groups are referred to it. I shall therefore confine my attention in the main to the Tertiary forms which have been described from American strata. A few Mesozoic types may be incidentally noticed.

In *Crassatellites*, as in *Mactra*, the essential features of the family began to crystallize in the middle and upper Cretaceous. Especially the descent of the resilium and ligament then began, and we find in the Cretaceous *Eriphyla* of Gabb the ligament still lingering externally, while in the Tertiary and recent *Crassinella* this organ has followed the resilium to the interior and is wholly cut off from the exterior. In the early *Crassatellites* the ligament and resilium, though internal, are small and by no means cover the space on the broad hinge-plate which they occupy in late Tertiary time. The posterior right cardinal and the fossette for the posterior cardinal of the opposite valve are affected by the pressure of the descending resilium and dwarfed by it, a condition which was observed by Conrad in *Crassatella vindinnensis* Orbigny, of the French Chalk, and upon which he founded his genus or subgenus *Pachythærus* in 1869. The same state of affairs is plainly visible in several of our Eocene species. The nepionic shell of some *Crassatellites*, including the Eocene type of the genus, is convex with a tendency to quadrangularity, while other species have it flattened and elongate-ovate or trigonal. Upon a young shell of this de-

scription Conrad founded his genus *Scambula* in 1869. *Crassatellina* of Meek, referred to this family by its author in 1871, does not belong here; it is a form closely allied to *Cyclas* Link, from which it and the synonymous *Etea* of Conrad differ by possessing lateral teeth and a more elongate and angular form. *Ptychomya* Agassiz is distinguished especially by the divaricate external sculpture (I have not been able to study the hinge, which is inaccurately described in the manuals) and is referred by Fischer to the *Veneridæ*. *Crassitina* Weinkauff, 1881, was proposed for the smaller recent species, which resemble *Pachythærus* except in the greater development of the resiliary pit.

The development and homologies of the hinge-teeth in *Crassatellites* present some difficulties. Disregarding the so-called internal position of the ligament common to most bivalves in the larval state, there can be no doubt that in the ancestors of this group the ligament and probably the resilium were external and, from the upper Cretaceous to the present day, the tendency of these organs has been to become more and more internal until both of them have no trace of externality. They have, in short, migrated ventrad.

According to the work of the lamented F. Bernard,* *C. plumbeus* and *C. lamellosus* exhibit in early stages of growth the following formula for the hinge: $\frac{\text{L. } 0l0.0101.0l0}{\text{R. } l0l.1010.l0l}$. Now in all my study of the hinges of our American fossil species and a considerable number of recent forms I have not found a formula of this kind. I have not been able to examine specimens less than three millimetres in diameter, but if the formula is as above even these should, I suppose, give evidence of it. The letter *l* in the above formula stands for lateral laminæ, and the ciphers for gaps or sockets into which laminæ or teeth fit.

According to my observations on American species the formula should be $\frac{\text{L. } l0l.0101l.0l0}{\text{R. } 0l0.1010l.l0l}$. That is to say, the right valve has always three cardinals, of which the posterior one is more or less smothered and obliterated by the descending resilium, while the left valve has only two cardinals. Furthermore, there are nowhere any developed laterals at all. What I have represented in the above formula by *l* may or may not be obsolete laterals, but, whatever view be taken of them, the facts are as follows: In the right valve the posterior hinge-margin is simply bevelled and is received into a groove in the corresponding part of the opposite valve; the right anterior hinge-margin has a shorter groove into which the bevelled edge of the left valve is received. There are no differentiated laminæ in the species I have examined. But in the little *Crassinella* (*mactracea*) or *Pseuderiphyla* the lower margin of each of these grooves be-

* Bull. Soc. Géol. de France, 3me Sér., xxiii., p. 121, 1895.

comes elevated and laminar, and at each end of the left posterior ventral lamina has a more raised portion, which might very well be termed a lateral tooth. One of these is directly behind the ligament and the other fits into a depression on the inner side of the bevelled posterior dorsal margin of the right valve very near its distal termination. I have not seen this development on any of the typical *Crassatellites,* yet I imagine it must occur on some of them, since Fischer in his Manual * speaks of " un dent cardinale postérieure rudimentaire" behind the ligament in the right valve. As a cardinal tooth, as ordinarily defined, cannot be situated *behind* the ligament in a Teleodont bivalve, this can be nothing but the elevated edge of the upper end of the lamina referred to, which is genetically the same as a cardinal. An examination of adult specimens of *Crassatellites plumbeus, lamellosus,* and a number of other Parisian species shows that in them the obliteration of the third cardinal is generally more complete than in most of the American forms of the same age, yet that traces of it may be observed in several of them; also that the type of the genus (*C. gibbosulus* Lamarck, according to Bronn) belongs to the type named by Conrad *Pachythœrus,* which is therefore an absolute synonym of *Crassatellites.*

Crassitina Weinkauff is only the modern representative of *Pachythœrus,* and therefore falls into the same synonymy.

Since the little shells which have been called *Gouldia, Pseuderiphyla,* and *Crassinella* have preserved their characters through the greater part of the Tertiary, it seems that they may properly be regarded as forming a valid group, though these characters are not very marked, except in size and form.

Excluding doubtful groups of Mesozoic age the following forms are known to belong to this family:

Genus *Remondia* Gabb, 1869. Type *R. furcata* Gabb, Comanche series. Cretaceous of Texas.

Shell resembling *Crassatellites,* but compressed, with the ligament partly external, the posterior third cardinal of the right valve present, the posterior margin of the right valve and the anterior of the left valve grooved to receive the laterals of the opposite valve.

Stearnsia (*Robbinsi*) White, 1887, is synonymous.

Genus *Crassatellites* Krüger, 1823.

Shell solid, inequilateral, slightly inequivalve, usually subtrigonal, the posterior end longer; valves closed, the ligament and resilium adjacent and in-

* Man. de Conchyliologie, p. 1021, 1887.

ternal; hinge of three cardinals in the right valve, of which the posterior is more or less effaced by the resilium, and two in the left valve; the anterior edge of the right and the posterior edge of the left hinge-margin grooved to receive the edge of the opposite valve, which is bevelled to serve as a lateral lamina; sculpture chiefly concentric and often obsolete except near the umbones.

Section *Crassatellites* s. s.

Valves with the nepionic shell convex; the adult more or less trigonal or quadrate, the third right cardinal usually perceptible below the scar of the resilium, the inner margins of the valves usually crenate.

Pachythærus Conrad, 1869, and *Crassitina* Weinkauff, 1881, are synonymous.

Section *Scambula* Conrad, 1869 (emended). Type *S. subplana* Conrad.

Valves with the nepionic shell flattened, the adult usually elongated, the third right cardinal obsolete or absent, the resilium large; the inner margins of the valves rarely crenate but usually smooth.

Subgenus *Micromeris* Conrad, 1866. Type *Astarte minutissima* Lea, 1833.

Shell minute, triangular, radially sculptured with internally crenate margins; resilium internal in front of the right posterior cardinal; lateral margins of the left valve fitting into grooves in the opposite margins of the right valve; anterior right cardinal obscure; pallial line entire. Formula $\frac{\text{L. } 1.10\text{r}10\text{l}0.1}{\text{R. } 0.01\text{r}0\text{l}01.0}$. *Pteromeris* Conrad, 1865, not 1862, is synonymous. The type is from the Claibornian and Lisbon Eocene. It is with some hesitation that I have left this and the following group here instead of transferring them to the *Condylocardiidæ*.

Subgenus *Cuna* Hedley, 1902. Type *C. concentrica* Hedley. Recent fauna of Australia.

Shell minute, trigonal, concentrically or radially sculptured, with crenate internal margins; resilium internal, behind the right posterior cardinal; posterior right and anterior left lateral margins fitting into sockets in the margin of the opposite valve; posterior left cardinal obscure, sometimes obsolete; pallial line entire; dental formula $\frac{\text{L. } 0.1\text{r}01010.1}{\text{R. } 1.0\text{r}10101.0}$, the anterior left and middle right cardinal teeth usually bifid or grooved.

This group is represented by recent species in the fauna of Australia and Japan and by one species in the Claibornian Eocene. It is very close to *Micro-*

meris, but the arrangement of the teeth differs somewhat. The American fossil was referred to *Micromeris* by Conrad, but its hinge agrees exactly with that of Hedley's type in all essentials.

Subgenus *Crassinella* Guppy, 1875 (not of Bayle, 1879). Types *Gouldia pacifica* C. B. Adams, and *Crassatella martinicensis* Orbigny.

Shell minute, subtriangular, much compressed; the umbones acute, subcentral; hinge with two cardinals in each valve, the lateral laminæ developed, the posterior left lateral lamellose behind the ligament; ligament and resilium internal; inner margins of the valves smooth. Formula $\frac{\text{L. } 0.101010.1}{\text{R. } 1.010101.0}$.

Gouldia (sp.) C. B. Adams, 1847 (not of Bonaparte, 1850); *Eriphyla* Dall, 1879 (not of Gabb, 1869), and *Pseuderiphyla* Fischer, 1887, are synonymous.

Genus *Eriphyla* Gabb, 1864. Type *E. umbonata* Gabb. Chico Cretaceous of California.

Shell like *Crassinella* but with the ligament and resilium chiefly external.

This genus bears nearly the same relation to *Crassinella* that *Remondia* does to *Crassatellites*. *Eriphylopsis* Meek, 1876, is synonymous. This group so far as known is confined to the Cretaceous.

Anthonya Gabb, 1864, is probably nearly related to *Remondia,* but is described as having only two cardinal teeth in each valve. I have not been able to compare specimens. It may bear to *Remondia* such a relation as *Scambula* bears to the typical *Crassatellites.*

Genus **CRASSATELLITES** Krüger.

Crassatellites Krüger, Arch. neuest Entd. Urwelt., ii., p. 466, 1823. Type *C. sinuatus* Krüger, = *Crassatella gibbosula* Lamarck, Ann. du Museum, vi., p. 410 (*fide* Bronn, Index Paleont., i., p. 344, 1848). Eocene.

<*Crassatella* Lamarck, Syst. An. s. Vert., p. 119, 1801 (not of Lamarck, Prodrome, p. 85, 1799. Type *Mactra cygnea* Chemnitz).

>*Pachythærus* Conrad, Am. Journ. Conch., v., p. 47, 1869; Proc. Acad. Nat. Sci. Phila. for 1872, p. 50. Type *Crassatella vindinnensis* Orbigny, Pal. Franç., Terr. Cret., iii., p. 78, pl. cclxvi., figs. 1–3. Cretaceous.

>*Scambula* Conrad, *op. cit.*, p. 48, 1869; p. 51, 1872. Type *S. perplana* Conrad, Am. Journ. Conch., v., p. 48, pl. ix., figs. 7–8, 1869. Upper Cretaceous.

>*Crassitina* Weinkauff, Marl. Chemn. Conch. Cab. Neue ausg., *Crassatella,* p. 1, 1881. Type *C. contraria* Gmelin.

Lamarck's original type for *Crassatella* was a typical *Mactra,* the type specimens of which, from the Chemnitz collection, are still preserved at Copenhagen. The next name in point of date is that of Krüger.

There are about twenty-five nominal species in our Eocene, a number which abundant material when gathered will afford means of considerably reducing. But six are known in the Oligocene and seven in the Neocene, the recent fauna comprising only three. The different horizons show with great uniformity two species each of *Crassinella,* three being known from the Atlantic and two from the Pacific American coast in the existing fauna.

In the Eocene *C. alæformis* Conrad, 1830 (+ *C. capricranium* Rogers, 1839, and *C. declivis* Heilprin, 1881), is the precursor of the Miocene Scambulas. A group of nominal species, several of which may prove to be forms of one specific type, contains *C. antestriatus* Gabb, 1860; *C. aquianus* Clark, Oct., 1895; *C. Halei* Harris, 1897; *C. sepulcollis* Harris, 1896; *C. texanus* Heilprin, 1890; *C. trapaquarus* Harris, April, 1895; *C. Gabbi* Safford, 1864 (= *C. pteropsis* Gabb, Mar., 1860, not of Conrad, Feb., 1860), and *C. mactropsis* Conrad, 1854 (as *Gratelupia,* + *antillarum* Gabb, 1873, non Reeve, 1842, + *C. Reevei* Gabb, 1873); *C. carolinensis* Conrad, 1875; *C. palmulus* Conrad, 1846; *C. rhomboideus* Conrad, 1865 (not of D'Archiac, 1840), and *C. obliquatus* Whitfield, 1885, are ill-defined or doubtful Eocene forms described from fragments or internal casts. *C. altus* Conrad, 1832 (+ *C. curtus* Conrad, 1862, described from a young valve with a wrong locality, the type being in the National Collection), a noble species from the Claibornian, first appears in the lower Claibornian of Texas, where it has been named *C. texalta* by Harris, 1895, and continues to the summit of the Vicksburgian, a very perfect cast having been obtained from Ocala, Florida, by Mr. Willcox. *C. tumidulus* Whitfield, 1865, from the Eocene of Alabama, is of somewhat the same type. Of a different form, elongated and carinate with numerous concentric ripples, are *C. protextus* Conrad, 1832, the commonest of the Claiborne species; *C. flexurus* Conrad, 1858 (+ *C. productus* Conrad, 1862), from the Jacksonian, and *C. littoralis* Conrad, 1869, a little known form from Shark River, New Jersey.

From the Pacific coast come *C. grandis* Gabb, 1864 (+ *C. altus* Conrad, 1855, not of Conrad, 1832); *C. compactus* Gabb, 1868; *C. uniodes* Stanton, 1896, and the dubious *C. uvasanus* Conrad, 1855.

The outline of most of the species is quite variable, as the figures of *C. densus* in this volume illustrate, and the extension of the concentric sculpture over the disk varies also. One of the most characteristic features of the several species lies in the sculpture of the nepionic shell at and near the umbones of the adult. This may occasionally be absent or obsolete, but when present, as it generally is, is very constant.

Crassatellites clarkensis Dall.

PLATE 36, FIGURES 20, 21, 24, 25.

Crassatellites clarkensis Dall, Trans. Wagner Inst., iii., pt. v., p. 1192, pl. xxxvi., figs. 20, 21, 24, 25, 1900.

Eocene of the Wahtubbee Hills, Clarke County, Mississippi, Burns; near Saline Bayou, St. Maurice, Louisiana, Vaughan; and at Claiborne, Alabama, L. C. Johnson.

Shell solid, elongated, moderately thick, inequilateral, the anterior end shorter, nearly equivalve; anterior end rounded, posterior end obliquely descending, pointed, and subrostrate, with a marked carina from the umbo to the posterior angle; lunule and escutcheon subequal, lanceolate, impressed; surface smooth except for incremental rugæ and microscopic radial striation; nepionic shell small with about six sharp, low, concentric ridges, which cease abruptly in less than three millimetres from the apex; hinge well developed; scars of ligament and resilium of moderate size; third right (posterior) cardinal nearly intact and distinct; anterior and basal margins sharply, finely crenate, the subsurface layer of the shell weathering out with distinct ribs corresponding to the crenations. Lon. 42.5, alt. 26.5, diam. 19.0 mm.

This resembles *C. protextus,* from which it is easily separable by its more pointed rostrum, sinuate below, and the very small space occupied by the nepionic sculpture, which in *C. protextus* extends over a radius on the disk of some eight or ten millimetres. The latter also has more conspicuous radial striation and coarser crenations.

Crassatellites (Scambula) psychopterus Dall.

PLATE 42, FIGURES 8, 9.

Crassatellites psychopterus Dall, Trans. Wagner Inst., iii., part v., p. 1198, pl. xlii., figures 8, 9, 1900.

Eocene of the Wahtubbee Hills, Clarke County, Mississippi; Burns.

Shell thin, flat, ovate, rounded in front and behind, the anterior end shorter; surface smooth except for incremental lines and three or four low, distant, concentric ridges; nepionic shell with little or no sculpture; lunule and escutcheon linear or obsolete; left valve with two well-marked cardinals, the posterior dorsal margin with a shallow groove for the edge of the opposite valve; basal margin with a row (in the adult) of minute pustuliform crenations. Lon. 20.0, alt. 15.0, semi-diameter 1.3 mm.

The single valves upon which (with a fragment of a larger specimen) this species is founded are undoubtedly young; the crenations do not appear on

their margins, though well developed on the fragment. It is not the young of any known species and it is highly probable that its remarkable compression is not materially altered in the adult.

The most common Oligocene species is *C. mississippiensis* Conrad, 1847, from the Vicksburgian. A shell described by Conrad under the name of *Gratelupia? mactropsis* was later referred by him to *Crassatellites* and identified by Gabb with an Oligocene species from St. Domingo and Costa Rica, which Gabb had named *C. Reevei*. It is uncertain whether Conrad's shell, which came from Gatun, on the Isthmus of Darien, was from the Eocene shales or the Oligocene sandstones of that locality, and I regard its identification with *C. Reevei* as open to question. Gabb figures only a fragment. The following are known from the Oligocene of Florida:

Crassatellites (Scambula) deformis Heilprin.

Crassatella deformis Heilprin, Trans. Wagner Inst., i., p. 117, pl. xvi., fig. 63, 1887.

Oligocene of the silex beds at Ballast Point, Tampa Bay, Florida; Dall and Willcox.

This species has the umbones notably flattened and is recognizable at once by its strong, concentric undulations over most of the shell, but having the posterior dorsal area unsculptured and the lunule and escutcheon deeply impressed. The scar of the resilium is unusually narrow and the third right cardinal nearly intact.

Crassatellites (Scambula) jamaicensis n. s.

Plate 49, Figure 13.

Crassatella marylandica Guppy, Proc. U. S. Nat. Mus., xix., No. 1110, p. 329, 1896; not of Conrad, 1838.

Oligocene marl of Bowden, Jamaica; Vendryes, Henderson, and Simpson.

Shell solid, nearly equilateral, subtrigonal, rounded below and in front with the posterior end obliquely subtruncate and a feeble carina bounding the posterior dorsal area; lunule and escutcheon subequal, moderately impressed; nepionic shell flattened, with seven or eight concentric low undulations, which extend down about one-fourth of the way to the basal margin mesially, and on the anterior slope are continuous, though the greater part of the disk and the whole of the posterior dorsal area are smooth except for incremental lines; hinge normal, the posterior right cardinal nearly obliterated; laminar grooves deep; internal margins of the valves smooth. Lon. 49, alt. 37, diam. 20 mm.

This has no resemblance to *marylandicus* but is more nearly like the *antestriatus* group of species.

Crassatellites (Scambula) chipolanus n. sp. ?

Plate 49, Figure 12.

Oligocene of the Chipola beds at Alum Bluff and on the Chipola River, Calhoun County, Florida.

Shell subtrigonal, solid, in general form resembling *C. jamaicensis*, but with the nepionic shell small and smooth or concentrically striate, followed by from two to four conspicuous rather distant concentric undulations, after which the whole surface (except the posterior dorsal area) is finely, closely, concentrically ribbed; other characters as in *C. jamaicensis*. Lon. 44, alt. 33, diam. 18 mm.

A variety approaches *C. jamaicensis* still more nearly by having the ribs obsolete on the middle of the disk. There is, as far as our material goes, no gradations between the two forms in the matter of the nepionic sculpture, but if further researches should demonstrate that such a gradation exists, this form would stand as a variety, *chipolana*, of the Jamaican shell.

Crassatellites (Scambula) densus Dall.

Plate 39, Figures 9, 10, 11, 12.

Crassatellites densus Dall, Trans. Wagner Inst., iii., pt. v., p. 1195, pl. xxxix., figs. 9–12, 1900.

Oligocene of the Oak Grove sands, at Oak Grove on the Yellow River, Santa Rosa County, Florida; Burns.

Shell elongate, plump, solid, and thick, the anterior end slightly shorter, the valves subequal; anterior end rounded, posterior end briefly truncate, subrostrate; lunule and escutcheon subequal, lanceolate, deeply impressed; beaks high, full, flattened at the apex; nepionic shell flat, apically smooth, with about five low, sharp, concentric rather distant waves, followed on the anterior slope by fine, close, concentric threading; the remainder of the shell smooth except for incremental lines; posterior dorsal area bounded by a rounded radial ridge, in front of which the shell is slightly constricted; halfway between this ridge and the border of the lunule is a second radial ridge but more faint; hinge normal, laminar grooves and adductor scars deep; internal margins of the valves smooth. Lon. 50, alt. 35, diam. 26 mm.

This is well-marked and elegant, recalling on a smaller scale the Miocene *C. turgidulus*.

Crassatellites (Scambula) melinus Conrad var. **meridionalis** Dall.

PLATE 37, FIGURES 6, 13.

Crassatella melina Conrad, Fos. Tert. Form., p. 23, pl. ix., fig. 2, 1832; Fos. Medial Tert., p. 22, pl. xii., fig. 2, 1838; Whitfield, Mioc. Lam. N. J., p. 60, pl. viii., figs. 11–13, 1895; Dall, Trans. Wagner Inst,, iii., part v., p. 1193, pl. xxxvii., figs. 6, 13, 1900.

The type in the Miocene of Shiloh and Jericho, Cumberland County, New Jersey; Plum Point, Maryland; the Eastern Shore of Virginia, and the variety at Alum Bluff, Florida.

The typical locality of the *Crassatella melina* was New Jersey, where it is the most common bivalve in the marls. The variety, which I have been tempted to call a species, differs from it in having the nepionic undulations continued on a radius of twelve millimetres or more, while in *melinus* the radius of undulation is not above seven millimetres; the southern shell is relatively less compressed; the anterior dorsal area is bounded by a ridge within which the impressed lunule occupies about half the area, while in typical *melinus* the margin is coincident throughout with the ridges proceeding from the beaks. The Florida shell is more attenuated behind, the dorsal slopes more steep, the margin of the base more rounded in front and more insinuated behind. But Plum Point specimens are to some extent intermediate between the two in some of these characters, so I prefer to regard the Alum Bluff shell for the present as a variety.

Crassatellites (Scambula) marylandicus Conrad.

Crassatella marylandica Conrad, Fos. Tert. Form., p. 22, pl. viii., fig. 1, 1832; Fos. Medial Tert., p. 21, pl. xii., fig. 1, 1838.

?Crassatella turgidula Conrad, Fos. Medial Tert., p. 69, pl. xxxix., fig. 7, 1843.

Miocene of the Choptank River, Maryland, Conrad; of the Patuxent River and Parker's Creek, Maryland, Burns and Harris.

This species as regards form bears to *C. turgidulus* Conrad almost exactly such a relation as *C. melinus* bears to the variety *meridionalis*. The nepionic shell of *C. marylandicus* has three or four feeble concentric undulations compressed into a radius of as many millimetres, while in *C. turgidulus* there are five or six rapidly increasing reaching to a radius of about fifteen millimetres but obsolete in front and behind. *C. marylandicus* has, like var. *meridionalis*, a rostrate, turgid form and high beaks; *C. turgidulus*, like *C. melinus*, comparatively low beaks, compressed or less turgid form, and broad posterior end. If *C. turgidula* is allowed specific rank, it would seem that the same should be accorded to the var. *meridionalis*.

Crassatellites (Scambula) undulatus Say.

Crassatella undulata Say, Journ. Acad. Nat. Sci. Phila., iv., p. 142, pl. xii., fig. 2, 1824; Conrad, Fos. Tert. Form., p. 23, pl. ix., fig. 1, 1832 (not of Sowerby, P. Z. S., 1832).

Miocene of Maryland, Say; of Grove Wharf, James River, of York River, City Point, and Petersburg, Virginia; of the Natural Well and Magnolia, Duplin County, North Carolina; of Murfreesboro', Green County, and Edgecombe County, North Carolina; and of Darlington Courthouse, South Carolina.

C. undulatus var. **cyclopterus** Dall.

Crassatella undulata var. Tuomey and Holmes, Pleioc. Fos. S. Car., pl. xx., fig. 8, 1856.

Miocene of Maryland and South Carolina, of Grove Wharf, James River, Virginia, and the Natural Well, Duplin County, North Carolina.

This variety differs from the typical form of the species in its shorter and higher form, more elevated beaks, more equilateral valves, and more pointed and less truncate posterior end. The measurements of the two may be compared.

	Lon.	Alt.	Diam.	Ant. end.	Truncation.
Type	120	70	26	30	35 mm.
Variety	110	80	30	38	18 mm.

If it were not for the fact that intermediate forms occur, it would be difficult to believe that the two extremes could be included under the same specific name. Conrad's *Crassatella planata,* described in 1866 from an internal cast obtained from the Miocene of New Jersey, was very possibly the cast of such a variety of *Crassatellites melinus.*

Another New Jersey cast was named by Conrad in the same year *Crassatella peralta,* but I have some doubt as to its being really Miocene. The only Pacific coast species from the Miocene, if it has been correctly assigned, is *Crassatella collina* Conrad, described in the Pacific Railway Reports (1857) and subsequently figured by Gabb, who reports it both from the Miocene and Pliocene of California. The recent *C. gibbosa* Sowerby has been reported by Nelson from beds probably Pliocene on the Peruvian coast.

Crassatellites (Scambula) Gibbesii Tuomey and Holmes.

Crassatella Gibbesii Tuomey and Holmes, Pleioc. Fos. S. Car., p. 74, pl. xx., figs. 9, 10, 1856; Emmons, Geol. Rep. N. Car., p. 290, fig. 216, 1858; Harris, Bull. Am. Pal., i., No. 3, p. 7, 1895.

Crassatella floridana Dall, Bull. Mus. Comp. Zool., xii., p. 256, pl. vi., fig. 12, 1886 (young shell); Bull. U. S. Nat. Mus. No. 37, p. 48, pl. vi., fig. 12; pl. xlii., fig. 4 (adult), 1889.

Upper Miocene of North Carolina at Wilmington and the Natural Well, Duplin County; also in the artesian well at Galveston, Texas, at a depth of 2158 to 2920 feet below the surface (Singley).

Pliocene of the Waccamaw beds in South Carolina and of the Caloosahatchie marl on Alligator Creek, near Charlotte Harbor, Florida; recent from the vicinity of Cape Hatteras, North Carolina, south to Barbados.

C. floridana was originally described from a very young shell. The receipt of adult specimens leaves no doubt of its identity with the South Carolinian fossil. It is stated by Ridewood that the animal of this species has a large saltatory foot and peculiarities of the gills not shared by the typical Asiatic species. This would seem to sustain the validity of the section.

The other West Indian species, *C. antillarum* Reeve, has not been found on the coast of the United States and appears to be extremely rare in the Antilles. No trace of it has yet occurred among fossils, and I have sometimes doubted whether the accepted locality, Margarita Island, is correct. The other species once referred to this region, *C. rostratus* Lamarck, is stated by the elder Sowerby to be a native of New Holland.

Venus virginica Gmelin, Syst. Nat., vi., p. 3294, No. 137 (after Lister, pl. cccxc., fig. 229, from Virginia), is a *Crassatellites*, but does not agree very well with any of the recent or fossil American species, being nearest some of the shorter and rounder varieties of *C. undulatus*. It was probably based on an exotic shell with a wrong locality label.

Subgenus CRASSINELLA Guppy.

Crassinella Guppy, Geol. Mag., Oct., 1874, p. 451. Types *C. pacifica* Adams and *C. martinicensis* Orbigny.

Thetis (sp.) C. B. Adams, Proc. Boston Soc. Nat. Hist., ii., p. 9, Jan., 1845; not *Thetis* Sowerby, 1826.

Gouldia (sp.) C. B. Adams, Cat. of Shells in (his) Collection, p. 29, note, Jan., 1847.

Eriphyla Dall, P. Z. S., 1879, p. 132; not of Gabb, 1864.

Pseuderiphyla Fischer, Man. de Conchyl., p. 1022, 1887. Type *C. martinicensis* Orbigny.

Crassinella Dall, Proc. U. S. Nat. Mus., xix., No. 1110, p. 326, 1896.

Not *Crassinella* Bayle, Expl. carte géol. de France, 1879.

The earliest members of this group so far reported from the Tertiary of the United States are *C. minor* Lea (as *Astarte*) from the Lisbon horizon and the Claiborne sands, and *C. pygmæa* Conrad (as *Gouldia*, Am. Journ. Conch.,

i., pp. 139, 212, pl. xxi., fig. 5, 1865) from the Jacksonian of Mississippi near Shubuta. The type of the latter is very minute (alt. circ. 1 mm.) and may be immature.

It is notable that in well-explored and especially recent faunas there are usually at least two species of *Crassinella* of which one is more triangular and solid, and the other flatter, thinner, and larger. The variations in outline, especially of the flatter forms, are considerable, and lead one to think that a diagnosis of any given species should aim at giving average and not merely individual characters, in order not to mislead.

Crassatellites (Crassinella) Guppyi Dall.

Crassinella miocenica Guppy, MS.

Crassatellites (Crassinella) Guppyi Dall, Proc. U. S. Nat. Mus., xix., p. 326, pl. xxx., fig. 5, 1896.

Crassinella martiniccnsis Guppy, Geol. Mag., dec. ii., vol. ii., No. 1, Jan., 1875; not of Orbigny.

Oligocene of Bowden, Jamaica, Vendryes; also Bland, Henderson, and Simpson; " Pliocene" of Matura, Trinidad, Guppy.

The specimens from Trinidad collected by Guppy appear to be specifically identical with those from Bowden in his collection, now in the National Museum.

Crassatellites (Crassinella) bowdenensis n. sp.

Plate 50, Figures 2, 3.

Oligocene of Bowden, Jamaica; Bland, Henderson, and Simpson.

Shell small, thick and solid, plump, subequilateral, the anterior side a little shorter; beaks small, acute, recurved; lunule and escutcheon lanceolate, subequal, well impressed, smooth; valves with subequal dorsal slopes and prominently arcuate base, sculptured with concentric, close-set, flattened threads, which near the umbones are less crowded and slightly sharper; hinge solid, strong, normal. Height 3.5, length 3.7, diameter 2.0 mm.

This is readily distinguished from *C. Guppyi* by its more convex form, heavy yet smaller shell, and finer sculpture.

Crassatellites (Crassinella) triangulatus n. sp.

Plate 49, Figure 16.

Oligocene of the Chipola beds at Alum Bluff, the Macdonald farm on the Chipola River, etc., Calhoun County, Florida; Burns and Dall.

Shell small, solid, rather compressed, subtriangular, subequilateral; dorsal slopes straight, nearly equal; beaks small, subacute, inclined towards each other; lunule and escutcheon narrow, elongate, emphatically impressed, smooth, subequal; sculpture varying from concentrically striated and nearly smooth to rather distantly feebly lamellose with wider interspaces, the sculpture more distinct, distant, and clean-cut, but less lamellose near the beaks; hinge-margin narrow; hinge delicate. Height 3.3, length 3.0, diameter 1.3 mm.

Not unlike *C. bowdenensis,* but more compressed, higher and shorter, with a different sculpture.

Crassatellites (Crassinella) tanicus n. sp.

PLATE 49, FIGURE 11.

Oligocene of Oak Grove, Santa Rosa County, Florida; Burns.

Shell small, resembling the last species in a general way, but with the concentric sculpture in small, smooth, low waves, more numerous and distinct on the beaks and becoming obsolete on the basal half of the shell, which is nearly smooth; there also appears to be rather more tendency to inequilaterality. Height 4.3, length 4.0, diameter 2.2 mm.

The sculpture of *C. triangulatus* is in rather sharp, raspy lamellæ, but that of *C. tanicus* is in low, rounded, rather flattish waves.

Crassatellites (Crassinella) lunulatus Conrad.

PLATE 49, FIGURE 15.

Astarte lunulata Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 133, 1834; Fos. Medial Tert., p. 44, pl. xxi., fig. 8, 1840; Am. Journ. Sci., 2d Ser., i., p. 404, 1846; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 72, pl. xx., fig. 4, 1856; Holmes, Post-Pl. Fos. S. Car., p. 32, pl. vi., fig. 9, 1858; *ex parte.*

Astarte mactracea Holmes, *loc. cit.,* not of Linsley, 1848.

Gouldia lunulata Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1862; Meek, S. I. Miocene Checklist., p. 7, 1864.

Miocene of Suffolk, Virginia (typical locality); of Magnolia and the Natural Well, Duplin County, North Carolina; Pliocene of the Waccamaw beds, South Carolina; of the Caloosahatchie beds, on the Caloosahatchie, Shell Creek, and Alligator Creek, Florida; Willcox and Dall.

This form is very similar to the recent *C. mactracea* Linsley from Connecticut, but the latter may usually be distinguished from it, when in good condition, by the fine, almost microscopic, radial striation which covers the shell and

which is absent from the fossil form. *C. mactracea* has not been seen by me in the fossil state if this character be required. However, I find southern specimens of the recent shell otherwise apparently identical are without the radial striation. The young shells are more transverse and more flattened as a rule; in outline and color they vary within wide limits. I find in one lot from a single locality specimens which might represent *C. guadalupensis* and *C. martinicensis* of Orbigny, *C. fastigiata* Gould, and *C. parva* C. B. Adams. I confess myself unable to formulate a diagnosis which will characterize more than one species among the recent forms of the Atlantic coast, though it is undeniable that specimens may be selected which will seem, without the connecting series, perfectly distinct. The fossil forms appear much more uniform in their characters. As *lunulata* is unquestionably the oldest specific name there is no doubt as to what we shall call the fossil, but the decision as to the recent forms must await better information.

Crassatellites (Crassinella) galvestonensis Harris.

PLATE 49, FIGURE 14.

Eriphyla galvestonensis Harris, Bull. Am. Pal., i., No. 3, p. 8, pl. i., figs. 2a, 2b, 1895.

Miocene of artesian well at Sea Isle City, New Jersey, at a depth of seven hundred and eighty-five feet, young specimens (Woolman); of St. Mary's, Maryland; Yorktown, Virginia (figured), and adjacent localities on the York River, and of the Galveston, Texas, artesian well, at a depth of four hundred and forty to four hundred and fifty-eight feet (Gwyn), the typical locality.

This form is rather convex, nearly equilateral, with very arcuate and somewhat swollen base, and is more nearly destitute of sculpture than any of the other species. The adults reach a height of 5.2 mm., a width of 5.5, and a diameter of 3.0 mm. A large proportion of the specimens found have been quite young and small.

Crassatellites (Crassinella) duplinianus n. sp.

PLATE 50, FIGURES 5, 6.

Miocene of the Natural Well and Magnolia, Duplin County, North Carolina, and Pliocene of Tilly's Lake, Waccamaw River, South Carolina; Burns and C. W. Johnson.

Shell small, subtriangular, solid, with markedly acute beaks, which incline backward; anterior slope convexly arcuate, long; posterior slope nearly a straight or slightly concave line, shorter; lunule and escutcheon extending the whole length of their respective slopes, long and narrow, the latter more ex-

cavated than the former and wider; both are smooth; base arcuate; disk sculptured with rather close-set, regular, subequal, flattish, concentric ridges with narrower interspaces; these are sometimes feebly elevated, but preserve their general close-set, regular character; hinge well developed, the posterior cardinal in the left valve often conspicuous. Height 3.2, breadth 3.2, diameter 1.7 mm.

This species is especially characterized by the closeness, regularity, and smoothness of its concentric ridges and the long and narrow lunule and escutcheon.

Crassatellites (Crassinella) acutus n. sp.

PLATE 50, FIGURES 1, 4.

Pliocene of the Caloosahatchie, Shell Creek, and Alligator Creek, Florida; Willcox, Burns, and Dall.

Shell small, solid, with very acute, slightly backwardly deflected beaks and wide, compressed base; lunule and anterior slope straight, of equal length, the lunule moderately impressed and smooth; posterior slope longer, somewhat excavated, the escutcheon well impressed, and in specimens with strong sculpture the carina bounding the escutcheon is often crenulated by the ends of the concentric ribs; sculpture of (about fifteen) medially rather elevated, narrow, even, regular, rounded ribs with much wider excavated interspaces, the ribs less conspicuous near the base and varying somewhat in strength in different individuals; disk but slightly convex, compressed towards the base, so that a section in profile would be wedge-shaped; hinge strong, the posterior cardinal in the left valve prominent but more or less coalescent with the dorsal margin. Height 4.0, breadth 4.3, diameter 1.8 mm.

This is a well-marked and pretty uniform species quite abundant in the Caloosahatchie Pliocene. The recent forms of the Atlantic coast may all be referred to the *C. lunulatus* Conrad, though the varieties are numerous. The Pacific *C. pacificus* is hardly distinguishable from *C. lunulatus,* but the *C. varians* Carpenter is a very well-defined form, characterized by its *Meretrix*-like outline, which is quite different from any of the other species. It ranges from Cape St. Lucas to Mazatlan, while *C. pacificus* has been obtained from San Diego, California, south to Panama.

Subgenus MICROMERIS Conrad.

Astarte (sp.) Lea, Contr. Geol., p. 64, 1833; H. C. Lea, Cat. Tert. Test. of U. S., p. 4, 1848.

Pteromeris (sp.) Conrad, Am. Journ. Conch., i., p. 9, 1865; not of Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, p. 578, 1863.

Micromeris Conrad, Checkl. Eocene Fos. N. Am., p. 5, May, 1866; Proc. Acad. Nat. Sci. Phila. for 1872, p. 51.

Pteromeris Stoliczka (following Conrad, 1865), Cret. Pelecypoda of India, p. 279, 1871; not of Conrad, 1862.

Micromeris Tryon, Struct. and Syst. Conch., iii., p. 229, 1884; Fischer, Man. de Conchyl., p. 1018, 1887; O. Meyer, Berichte Senckenb. Ges., 1887, p. 11: Cossmann, Notes Compl., Eoc. Ala., p. 13, 1894.

The type of this group is the following species:

Crassatellites (Micromeris) minutissimus Lea.

Astarte minutissima Lea, Contr. Geol., p. 64, pl. ii., fig. 39, 1833.

This little species is so minute that a study of its hinge involves some difficulty. Under an ordinary magnifier it appears to have two arcuate cardinals in each valve. Thorough study under a compound microscope shows that a very feeble right anterior and left posterior cardinal tooth is also present in well-developed and preserved specimens, the former frequently hardly visible. The resilium is occasionally preserved in closed pairs of this fossil, which is quite a help in making out the hinge. The anterior end of the shell is more produced and has the longer slope of the two dorsal margins. Meyer's *M. senex* does not appear to differ appreciably from a very young *Venericardia*. The species is also reported from the Jacksonian. *Cardita atomus* Deshayes, of the Parisian Eocene, was compared with this species by Conrad, but it seems to have the hinge of *Pleuromeris*.

The *Astarte minor* of Lea, which was included in *Micromeris* by Conrad, is a typical *Crassinella* and, of course, entirely distinct from Lea's *Astarte parva*, with which Conrad and others have sometimes united it.

Subgenus **CUNA** Hedley.

Cuna Hedley, Memoirs of the Australian Museum, iv., part v., p. 314, July, 1902. Type *C. concentrica* Hedley, *op. cit.*, p. 315, fig. 55.

Crassatellites (Cuna) parvus Lea.

Astarte parva Lea, Contr. Geol., p. 63, pl. ii., fig. 37, 1833.

Micromeris parva Conrad, Checkl. Eocene Fos. N. Am., p. 5, 1866; Stoliczka, Cret. Pelecypoda of India, p. 279, 1871; Cossmann, Notes Compl. Eoc. Ala., p. 13, 1894.

Astarte (*Micromeris*) *parva* Gregorio, Mon. Claib., p. 200, pl. xxvii., figs. 20, 31, 32, 33, 1890.

Astarte monroensis O. Meyer, Ber. Senckenb. Ges., 1887, p. 10, pl. ii., fig. 6; Gregorio, *op. cit.*, p. 201, 1890, pl. xxvii., figs. 32–33.

Astarte (*Micromeris*) *subparva* O. Meyer, *op. cit.*, p. 11, pt. ii., fig. 5, 1887; Gregorio, *op. cit.*, p. 201, pl. xxvii., fig. 20, 1890.

Claibornian Eocene of Claiborne, Monroe County, Alabama; Lea, Meyer, Burns, *et al.*

The type of this group is a little shell with concentric sculpture and crenulate inner margin; several other recent Australian species are included with it. I have a recent species with strong radial ribs, from Japan, not yet described, and the present species from the Eocene of Alabama. Tate also mentions a specimen from the Australian Tertiary. In the hinge of this group the resilium is rounded and just below the cardinal margin, which is often marked by a minute fissure just above it, though I do not feel sure that this is not due to breakage in opening the shell. It occurs in most but not all the fossil specimens. Below the resilium is a thin, imperfectly developed posterior cardinal in the right valve, and in front of that a large more or less bifid tooth. The anterior lateral margin is grooved to receive the edge of the opposite valve, and the edge just in front of the beak is curved, thickened, and a little elevated in *C. parvus*, indicating a feeble anterior cardinal, sometimes obsolete. In the left valve there are two well-marked cardinals, the anterior of which is feebly grooved and the posterior margin where it curves around the resilium is thickened and slightly elevated, denoting an obsolete posterior cardinal. From Hedley's excellent figures it is evident that the correspondence of the parts of the hinge is nearly exact. From *Micromeris* the group differs by having the lateral grooves one on each valve, instead of both on one valve, and also by the resilium being situated above and behind the posterior right cardinal, instead of in front of it. After an examination of the types I quite agree with Cossmann in uniting Meyer's two species with that of Lea, of which they appear to be mutations.

Conrad for a time, judging by Lea's figures alone, united this with Lea's *Crassinella minor;* but this was an error, which he corrected in 1866.

Family ASTARTIDÆ.

This group is of very recent differentiation, and previous to the Cretaceous could not well have been separated from the *Crassatellitidæ*, from which it now differs chiefly by its wholly external ligament and resilium. The Cretaceous *Eryphyla*, apparently ancestral to the group called *Crassinella*, has its ligament external, yet it is obviously closer to the *Crassatellites* type by its

other morphologic features than to *Astarte,* which agrees in that particular especially. *Lirodiscus* by its flattened umbones recalls *Scambula,* and in the characteristics of the periostracum the two families are also similar. *Crassatellites* for some reason has succeeded in occupying a place in the warmer seas, while the *Astarte* type in the main is a denizen of the colder waters, the species entering the milder zone being invariably of small size. Correlated with the difference of habitat is the greater tendency to develop color or color markings in *Crassatellites.*

My observations on the hinge agree essentially with Bernard's as regards variability and the development or abortion of particular elements of the dentition. I have not found, however, traces of more than three cardinals in either valve, the number actually figured by Bernard. The hinge-formula is as follows: $\frac{\text{L. } 0.101010.1}{\text{R. } 1.010101.0}$.

The laterals are formed by an extension of the valve-margin, which fits into a socket on the edge of the opposite valve; they usually alternate, one socket and one lateral to each valve. Bernard has formulated the edges of the socket as two laterals, but this seems hardly worth while. The middle cardinals are usually strongly developed and sometimes longitudinally striated or bifid; the anterior right and posterior left cardinals are nearly always (and the posterior right cardinal frequently) obsolete, or represented by mere traces; the other teeth in the adult are usually well marked. Like *Crassatellites* and *Cardita,* the sides of the cardinals may, and frequently do, develop more or less transverse striation; in *Astarte* proper this feature is more common in the fossil than in the recent species.

No *Astarte* has radial ribbing, but many of them develop crenulations on the inner margins of the valves when adult, or at the resting stages of the practically mature individual. Between these stages the same individual may be destitute of crenulations, while, on the other hand, some species always, and others never, have them. A peculiarity which has been noticed in several of the genera of *Astartidæ* is the tendency to reversal of the hinge-teeth in relation to the valves, the dentition normal to the right valve being found in the left, and *vice versa.* This peculiarity is especially notable in *Goodallia,* where, out of one lot examined, nearly one-third had the hinge reversed. The strength of the laterals is also very variable; some species have them strong and prominent, in others they are almost wholly obsolete, with every intermediate gradation in the series of species.

The distinctions upon which the groups under *Astartidæ* are based are chiefly those of greater or less development of the hinge-teeth and differences

of external sculpture. As the type of the hinge-formula does not change, it will be inferred that these distinctions are not of great weight.

Geologically the group is an old one; in America typical Astartes occur in the middle portion of the Comanche series of the Texas Cretaceous, but whether certain Paleozoic forms which have been called *Astarte* really belong to the genus or not is somewhat uncertain.

Genus LIRODISCUS Conrad.

Lirodiscus Conrad, Am. Journ. Conch., v., p. 46, 1869; type *Astarte tellinoides* Conrad; Tryon, Struct. and Syst. Conch., iii., p. 227, 1884; Fischer, Man. Conchyl., p. 1016, 1887.

Shell solid, subelongate, inequilateral, equivalve; the nepionic valves flat, usually concentrically ridged, the later portion of the disk more convex; ligament normal, external; resilium separate, situated between the beaks, external but with its base partly immersed and encroaching on the upper part of the cardinal teeth; dental formula $\frac{\text{L. } 01.1010.01}{\text{R. } 10.0101.10}$; the left anterior lateral represented by the bevelled edge of the valve and sometimes indistinct; cardinals transversely striate laterally; inner margins crenate; adductor scars rounded with elevated margins. Type *Astarte tellinoides* Conrad, Claibornian Eocene (+ *A. Nicklini* Lea and *A. sulcata* Lea, 1833, not Da Costa, 1778).

This genus is characteristic of the Eocene and appears in the Midwayan as *L. subpontis* and *mediavius* Harris; in the Chickasawan as *L. smithvillensis* Harris; and at Wood's Bluff, Alabama, in Clarke County, Mississippi, and Lee County, Texas, as *L. protractus* O. Meyer typically of the lower Claibornian; in the Claibornian it is represented by *L. tellinoides;* and in the Jacksonian by the following species:

Lirodiscus Wailesii n. sp.

PLATE 57, FIGURE 21.

Astarte paralis Conrad, in Wailes, Agr. and Geol. Miss., pl. xiv., fig. 2, 1854; S. I. Eocene Checkl., p. 23, 1866; not of Conrad, Journ. Acad. Nat. Sci. Phila., 2d Ser., ii., p. 276, pl. xxiv., fig. 16, 1853 (Cretaceous).

Jacksonian Eocene of Jackson, Mississippi, Vince's Bluff, Arkansas, and Montgomery, Louisiana; Burns, Harris, and Vaughan.

Shell subovate, with high, flat, nearly smooth beaks, the remainder of the disk finely, concentrically ribbed with narrow, rather elevated ridges and wider interspaces; beaks pointed, prosogyrate; lunule smooth, sublanceolate, rather deeply excavated; escutcheon longer, narrower, and less impressed; posterior

end hardly rostrate; hinge normal, basal margins finely crenate; adductor scars slightly raised. Length 18.0, height 15.2, diameter 8.0 mm.

The nepionic shell in this species is smaller and smoother and the ribbing of the disk less coarse than in the other species. The rostration, which is so marked a feature in *L. tellinoides,* is not found in this or the lower Eocene species.

Lirodiscus protractus O. Meyer.

PLATE 43, FIGURE 3.

Astarte protracta O. Meyer, Bull. Ala. Geol. Survey, i., p. 80, pl. iii., figs. 18, 18a, 1886; Dall, Trans. Wagner Inst., iii., p. 1199, 1900.

Astarte smithvillensis (var. *mediavia*) Harris, Bull. Am. Pal., i., No. 4, p. 61, pl. v., fig. 4, 1896; not Harris, Proc. Acad. Nat. Sci. for 1895, p. 48, pl. i., figs. 8, 9, 1895.

?Astarte subpontis Harris, Bull. Am. Pal., i., No. 4, p. 62, pl. v., figs. 5a–b, 1896; uppermost midwayan Eocene.

Upper bed at Enterprise, Mississippi, lower Claibornian, O. Meyer; Naheola Landing, Tombigbee River, and Mathews Landing, Alabama River, midwayan Eocene, Harris.

This form appears to be very mutable, and the consolidation above indicated is suggested on the basis of specimens named by Professor Harris in the collection of the National Museum.

The *A. smithvillensis* of Harris is said to be the *A. Conradi* Buckley, 1874, not of Dana, "Manual of Geology," 1863.

The genus *Goodalliopsis* De Raincourt and Munier-Chalmas, 1863, which is placed by Fischer in the *Astartidæ,* should be transferred to the *Erycinidæ* (as a synonym of *Kellia*), as previously indicated by Cossmann. *Bernayia* Cossmann, 1887, accidentally omitted from my review of the Leptonacea, should also, from the figures, belong in the vicinity of *Kellia.*

A careful examination of the type of *Plesiastarte* Fischer, 1887, leads to the conclusion that Deshayes in referring it to the *Cyrenidæ* had much justification. It has none of the characteristics of the *Astartidæ.* On the other hand, a little shell described by Gould from Japan, under the name of *Gouldia dilecta,* has identically the same hinge characters, except that the lateral lamina is not cross-striated. I suspect the latter to be the very young shell of some Venerid allied to *Meretrix.*

I have not been able to examine authentic specimens of the Mesozoic *Præconia* Stoliczka, 1871, and *Pachytypus* Munier-Chalmas, 1887. *Parisiella* Cossmann, 1887, from the Parisian Eocene, is also only known to me by

figures. The cardinal dentition appears to resemble that of *Microstagon* and there is a feeble anterior lateral on each valve. On the whole it seems probably a member of this family.

Genus **ASTARTE** Sowerby.

Astarte Sby., Min. Conch., ii., p. 85, tab. 137, 1816; Gen. Shells, pt. iv., 1822; Lajonkaire, Mém. Soc. d'hist. nat. Paris, i., p. 29, 1823; E. A. Smith, Journ. Conch., iii., pp. 196–232, 1881.

Tridonta Schumacher, Essai, p. 146, 1817. Type *Venus borealis* Chemnitz; Möller, Isis, p. 135, 1832.

Crassina Lamarck, An. s. Vert., v., p. 554, 1818; Leach, Ross's Voyage, App., ii., p. lxii., 1819, sole example *C. scotica;* Schweigger, Naturg., p. 710, 1820; Blainville, Man. Mal., p. 557, 1825; Hanley, Ill. Cat., i., p. 87, 1844; Leach, Syn. Moll. Great Brit., p. 301, 1852; Chenu, Man. Conch., ii., p. 130, 1862.

Triodonta Agassiz, Nomenclator, Index, p. 1087, 1847; not of Bory St. Vincent, 1824.

Nicania Leach, Ross's Voyage, App., ii., p. lxii., 1819; Journ. de Physique, lxxxviii., p. 465, 1819; types *N. Banksii* and *N. striata* Leach, *op. cit.;* Thompson's Ann. Phil., xiv., p. 204, 1819; Gray, Parry's Voy., App., p. ccxlii., 1824; Zoological Journ., i., p. 119, 1824; Mörch, Greenland Moll. in Adm. Man., p. 132, 1875; Sars, Moll. Reg. Arct. Norveg., p. 51, 1878; Fischer, Man. de Conchyl., p. 1016, 1887.

Tridenta Sowerby, Conch. Icon., xix., Mon. *Astarte,* 1874; err. typ. pro *Tridonta.*

Tridonta Mörch, Adm. Man., p. 132 (*A. borealis* Schum.), 1875; Sars, Moll. Reg. Arct. Norv., p. 50, 1878; Fischer, Man. de Conchyl., p. 1016, 1887.

Gonilia Stoliczka, Cret. Pel. India, p. 278, 1871, type *Lucina bipartita* Philippi; Tryon, Proc. Acad. Nat. Sci. Phila., 1872, p. 248; Smith, Journ. Conch., iii., p. 232, 1881; Fischer, Man. de Conchyl., p. 1016, 1887.

Crassinella Bayle, Explic. de la carte Géol. de France, 1879, type *Astarte obliqua* Deshayes, Bajocien; not of Guppy, Geol. Mag., ii., vol. ii., p. 451, 1874.

Neocrassina Fischer, Man. de Conchyl., p. 1016, 1887; new name for *Crassinella* Bayle non Guppy.

Grotriania Speyer, Zeitschr. d. Deutsch. Geol. Ges., xii., p. 496, 1860. Type *G. semicostata* Speyer. Oligocene.

Digitaria S. V. Wood, Crag. Moll., Bivalves, p. 191, 1853. Type *D. vulgaris* Wood, = *Tellina digitaria* Linné.

Woodia Deshayes, An. s. Vert. bassin de Paris, i., p. 790, 1860; Stoliczka, Cret. Pel. India, p. 280, 1871; *Tellina digitaria* Linné.

Crenimargo Cossmann, Cat. Illustré, App. iii., Dec., 1902. Type *C. inæquicrenata* Cossmann. Eocene.

Rictocyma Dall, Am. Journ. Conch., vii., p. 151, 1872. Type *A. mirabilis* Dall.

Rhectocyma von Martens, Zool. Rec., 1872, p. 170, 1874; new name for *Rictocyma* Dall.

Goodallia Turton, Dithyra Brit., p. 76, 1822. Type *Mactra triangularis* Montagu.

Mactrina Brown, Ill. Conch. Gt. Brit., expl. pl. xvi., fig. 25, 1827 (= *Mactra triangularis* Montagu) = *Goodallia* Turton.

Microstagon Cossmann, Cat. Illustr. bassin de Paris, App. ii., p. 11, 1896. No type cited.

Ligament enfolding the resilium, both external on narrow nymphs. The characteristics of this genus are set forth to a great extent in the remarks under the head of *Astartidæ,* and it will be reasonably clear to the reader that a certain variability in characters usually stable is a marked feature of the genus. After much study of recent species and the diagnoses of groups found in the literature, I am of the opinion that these variations for the most part are such as cannot be properly used for the subdivision of the genus. The crenulation of the margin of the valves is not more than of specific value; the obsolescence of the terminal cardinal teeth of the hinge, the greater or less prominence of the lateral laminæ, are characters which in this genus I have found inconstant even in the species. The flattening of the umbones, which is so conspicuous a character in many of the fossil species when a series of species is studied, is seen to be so gradually modified between one species and another as to admit of no hard and fast line being drawn between those with and those without this character. By taking a single recent species to compare with some fossil form it may chance that marked discrepancies may be noted, but if a series of species be compared, these discrepancies will be found inconstant.

The three earlier names, *Astarte, Tridonta,* and *Crassina,* practically cover the same ground, the only difference being that *Tridonta* always has a smooth inner margin while the fully developed type of the other groups has a crenulated border. Why Leach should have given a new name to his two small species is problematical; one is sulcate, the other nearly smooth externally, so it could not have been based on the sculpture. Both, however, were smaller than the average British species and both had smooth margins. I have not been able to examine specimens of *Grotriania,* but I have been unable to find anything in the diagnoses or figures which authorizes us to separate it from *Astarte; Gonilia, Digitaria,* and *Rictocyma* are sections frankly based on peculiarities of external sculpture. *Neocrassina* is simply unusually inequilateral. In *Goodallia* the hinge is reduced by the loss of anterior cardinals, but the laterals still persist, though feeble. In its Eocene ancestor *Microstagon* one of the lost cardinals can still be detected, though the laterals are inconstant among the species.

The genus may be divided, so far as its Tertiary and recent forms are concerned, as follows:

Section *Astarte* s. s.

Dental formula $\frac{L.\ 0.101010.1}{R.\ 1.010101.0}$, the middle right and two anterior left cardinals strong, the others obsolete; valves with convex umbones, subequilateral, the inner margins, when fully developed, crenate. Type *A. sulcata* Da Costa.

Section *Tridonta* Schumacher.

Like *Astarte* s. s., but the umbones very anterior, nearly terminal. Type *A. borealis* Schumacher (= *semisulcata* Leach).

?Section *Neocrassina* Fischer.

Like *Astarte* s. s., but the umbones very anterior, nearly terminal. Type *A. obliqua* (Lam.) Deshayes.

Section *Rictocyma* Dall.

Shell small, with convex umbones; resembling *Astarte*, but the concentric waves near the umbones broken, bifid, or irregular; inner margins smooth. Type *Crassatella esquimalti* Baird.

Section *Ashtarotha* Dall, 1903.

Umbones conspicuously flattened and concentrically sculptured; valves usually smoother outside of the flattened area; otherwise like *Astarte* s. s. Type *Astarte undulata* Say. Miocene.

Section *Gonilia* Stoliczka.

Hinge as in *Astarte;* valves small, lentiform, with divaricate ribbing on the central part of the disk. The large cardinals are bifid. Type *Lucina bipartita* Philippi (= *Astarte bipartita* Stoliczka, 1871, not of Sowerby, 1829, = *A. calliglypta* Dall, 1903). Recent.

Section *Digitaria* Wood.

Valves rotund; surface arcuately, obliquely sulcate; shell small, lentiform; hinge as in *Gonilia;* the inner margins more or less tangentially sulcate by the encroachment of the external sulci. Type *Tellina digitaria* Linné. *Woodia* Deshayes is synonymous. Recent and Pliocene.

Section *Crenimargo* Cossmann.

Shell thin, like *Digitaria,* but without external oblique sulci, the tangential sulcations of the inner margin present and resembling those of *Transennella;* hinge as in *Digitaria.* Type *C. inæquicrenata* Cossmann. Eocene of Paris.

Subgenus *Goodallia* Turton.

Shell small, smooth, the hinge-teeth reduced by the absence of the anterior

or posterior right cardinal or both of them, the hinge frequently reversed as regards the valves; inner margins crenate when fully developed or at resting stages, but at other times smooth; formula $\frac{\text{L. } 0.101.1}{\text{R. } 1.010.0}$. Type *Mactra triangularis* Montagu. *Mactrina* Brown is synonymous.

Section *Microstagon* Cossmann.

Shell small, resembling *Goodallia,* the hinge usually with one or both laterals obsolete, but a small right (usually anterior) cardinal present which is not found in *Goodallia* proper. Formula $\frac{\text{L. } 1010.}{\text{R. } 0101.}$ (*herouvalense*) or $\frac{\text{L. } 1010.1}{\text{R. } 0101.0}$ (*pernitidum*). Type *Goodallia herouvalensis* Deshayes. Eocene of Paris.

Of the Eocene species of *Astarte*, *A. marylandica* Clark, 1896, is a precursor of the species like *A. obruta* in the Miocene. *A. castanella* and *A. planimarginata* Whitfield, 1885, are represented only by internal casts and hardly recognizable. *A. Aldrichiana* Harris from the figures has the aspect of a *Crassinella,* but I have not seen specimens. *A. triangulata* O. Meyer, 1896, from the Red Bluff beds of Wayne County, Mississippi, is small, triangular, and with a very deeply impressed lunule. Other species named by Lea belong to subdivisions of the *Crassatellitidæ,* under which reference has already been made to them.

Astarte Wagneri n. sp.

Plate 57, Figure 20.

Oligocene of the Oak Grove sands, at Oak Grove, Santa Rosa County, Florida; Burns.

Shell small, subtrigonal, nearly equilateral, with high, pointed, convex, prosogyrate beaks overhanging a very short cordate, deeply excavated lunule; escutcheon narrow, hardly defined; sculpture of about fifteen low, rounded, concentric waves with narrower interspaces, and fine, concentric striation more or less obsolete; hinge compressed by the deep lunule, otherwise normal; inner margins smooth; muscular impressions rather small, impressed. Height 10, length 11, diameter 4 mm.

The most striking characteristic of this species is the deep and very short lunule.

Astarte symmetrica Conrad.

Astarte symmetrica Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 134, 1834; Fos. Medial Tert., p. 44, pl. xxi., fig. 7, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Mioc. Fos. N. Am., p. 7, 1864; Whitfield, Mio. Moll. N. Jer., p. 54, pl. viii., figs. 1, 2, 1895.

Astarte arata Conrad, Fos. Medial Tert., p. 42, pl. xx., fig. 8, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 577, 1863.

Miocene of Maryland, on St. Mary's River, and of Virginia at Petersburg and three miles south of City Point on the James River.

This is a species with rude, half-obsolete, concentric sculpture often nearly smooth and of a rounded trigonal, subequilateral form. The variety *arata* Conrad differs only by having more elevated and pointed beaks, by which the lunule and escutcheon are somewhat elongated.

Astarte vicina Say.

Astarte vicina Say, Journ. Acad. Nat. Sci. Phila., iv., p. 151, pl. ix., fig. 6, 1824; Morton, Synops. Org. Rem., App., p. 3, 1834; Conrad, Fos. Medial Tert., p. 41, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Mioc. N. Am., p. 7, 1864.

Miocene of Maryland at Plum Point and its vicinity, and of Virginia at Grove Wharf on the James River.

This species appears to be rare and for that reason seems to have been misunderstood, especially as Say's figure is rather rude. He contrasted it with *undulata* and emphasized the deep lunule. It is separated from the whole *undulata* group by its unflattened umbones; it is nearest to *A. exaltata* Conrad, which, however, never reaches the size noted by Say for *A. vicina,* is more rounded behind, less elongate, and with proportionately higher umbones. The inner margins of *A. vicina* are crenate at resting-stages, but many of the specimens have no crenations. The lunule is smooth and deeply excavated.

Astarte exaltata Conrad.

Astarte exaltata Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 29, 1841; Journ. Acad. Nat. Sci. Phila., viii., p. 185, 1842; Fos. Medial Tert., p. 66, pl. xxxvii., fig. 6, 1845; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Miocene of Maryland, at Calvert Cliffs and Plum Point and vicinity; of Virginia, at various localities on the York River; and in the phosphatized Miocene limestone of the Ashley River, South Carolina; Harris, Burns, and Dall.

A small, high species, with a very much impressed lunule and pointed, concentrically sculptured beaks, the concentric sculpture obsolete towards the ventral margins.

Astarte Coheni Conrad.

Astarte Coheni Conrad, Fos. Medial Tert., p. 43, pl. xxi., fig. 5, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

?Astarte Thomasi Conrad, Proc. Acad. Nat. Sci. Phila., vii., p. 267, 1855; xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864; Conrad, Am. Journ. Conch., ii., p. 72, pl. iv., fig. 16, 1866; Whitfield, Mioc. Moll. N. Jer., p. 55, pl. viii., figs. 3–7, 1895.

Miocene of Virginia, at various localities on the York River, at Gaskin's and Lee's Wharves on the Nansemond River, and at Petersburg and its vicinity.

This is a small and elegantly rounded subtrigonal species, with concentric regular sulci with much wider interspaces, and crenate inner margins. It is the most common species in the York River Miocene.

Astarte Glenni n. sp.

Miocene of the Darlington district, South Carolina; Burns and Glenn.

Shell small, compressed, triangular, elevated, subequilateral, smooth or faintly concentrically striated, with high, pointed, slightly prosogyrate beaks; lunule smooth, elongate, narrow, moderately impressed; escutcheon similar but nearly as long as the whole posterior slope; ligamentary nymphs short; hinge normal; adductor scars rather small and the pallial line pretty close to the ventral margin, which is conspicuously and elegantly crenate. Length 10, height 10, diameter 4 mm.

This is a very pretty and very distinct species, which I have named in honor of Professor L. C. Glenn, of Vanderbilt University, who collected it with many other fossils of the Darlington district.

Astarte sp.

Miocene gravels of Gay Head, Martha's Vineyard, Massachusetts; Dall and Foerste.

A species resembling *A. sulcata* Da Costa is found in these gravels, represented by molds which are hardly perfect enough to serve as the basis of a specific description in so variable a group.

Astarte (Ashtarotha) obruta Conrad.

Astarte obruta Conrad, Morton, Syn. Org. Rem., App., p. 3, 1834 (name only); Fos. Medial Tert., p. 43, pl. xxi., fig. 2, 1840; Proc. Acad. Nat. Sci. Phila., vii., p. 150, 1855; xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Astarte virginica Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 578, 585, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

?Astarte castrana Glenn.

Older Miocene of Easton, Maryland, Conrad; Miocene of Calvert County and the Choptank River, and at and near Plum Point and Reeds, Maryland; also in the Miocene of Virginia, Conrad.

This is an abundant species of rounded trigonal shape with moderately elevated, flattened beaks, sculptured with strong, concentric ridges, the rest of the disk remaining nearly smooth. The *Astarte castrana* of Glenn from an examination of the types appears extremely similar to the adolescent individuals of this species.

Astarte (Ashtarotha) undulata Say.

Astarte undulata Say, Journ. Acad. Nat. Sci. Phila., iv., p. 150, pl. ix., fig. 5, 1824; Conrad, in Morton, Syn. Org. Rem., App., p. 3, 1834; Fos. Medial Tert., p. 41, pl. xx., fig. 7, xxi., fig. 4, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 70, pl. xx., fig. 12, 1857; Emmons, Geol. Rep. N. Car., p. 289, fig. 213, 1858; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Astarte thisphila Glenn.

Miocene of Maryland at Jones Wharf, Calvert Cliffs near Governor's Run, and near Greensboro'; of Virginia at and near Petersburg, City Point, and Grove Wharf on the James River, the upper bed on the York River, and at various localities on the Nansemond River, near Suffolk; of Duplin County, North Carolina, at the Natural Well and Magnolia, and in the Sumter Miocene of South Carolina.

The variety *vaginulata* was obtained at Grove Wharf on the James River, Virginia.

This is the most abundant of our Miocene species, short, high, with flattened gibbous umbones and a few broad undulations, the ventral third of the shell smooth or faintly striated. The outline is quite variable and the inner margins crenulate. It recalls the *A. bipartita* Sowerby from the Suffolk Crag of England.

Astarte undulata var. vaginulata Dall.

This differs from the typical *undulata* in being more triangular, with a straighter base, smaller, flattened area on the beaks, with finer concentric sulcation which extends in most specimens to the base of the shell, though somewhat irregularly.

The *A. thisphila* Glenn appears from an examination of the types to be founded on adolescent specimens of *A. undulata*, which are slightly more compressed, relatively, than the perfectly adult shells.

Astarte (Ashtarotha) concentrica Conrad.

Astarte concentrica Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 133, 1834; Morton, Syn. Org. Rem., App., p. 3, 1834; Fos. Medial Tert., p. 44, pl. xxi., fig. 6, 1840; Emmons, Geol. Rep. N. Car., p. 289, fig. 212, 1858; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Not *Astarte concentrica* Goldfuss, 1842, nor Roemer, 1852.

A. concentrica var. **bella** Conrad.

Astarte lineolata H. C. Lea, Trans. Am. Phil. Soc., 2d Ser., ix., p. 241, pl. xxxiv., fig. 20, 1846; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864; not *A. lineolata* Roemer, 1852.

Astarte concentrica Tuomey and Holmes, Pleioc. Fos. S. Car., p. 71, pl. xx., fig. 3, 1857.

Astarte bella Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 577, 585, 1863.

Astarte compsonema Conrad, Am. Journ. Conch., ii., p. 72, pl. iv., fig. 18, 1866.

Miocene of Virginia at and near Petersburg, at various localities on the York River, Coggins Point, on the banks of the Nansemond River at Lee's and Gaskin's Wharves; of North Carolina at Magnolia and the Natural Well, Duplin County; of South Carolina at Shell Branch in the Darlington district; Pliocene of the Waccamaw beds, South Carolina. The variety is known from the Miocene of Petersburg, Virginia, and the Pliocene of the Waccamaw River, South Carolina.

This is an abundant and rather elegant species, varying chiefly in relative height of the beaks and the finer or coarser concentric sculpture. The specimens from Duplin County, North Carolina, are smaller than those from Virginia but otherwise identical. This difference may be due to an accident of collecting. *A. lineolata* H. C. Lea was described from a very young shell of this species. Conrad's name of *bella* was bestowed on a short, high variety figured by Tuomey and Holmes from the Pliocene, and three years later he named the same thing from the Miocene of Virginia *A. compsonema*.

A. calvertensis Glenn, from the Miocene of Plum Point, Maryland, is very close to *A. concentrica* in sculpture, but is much flatter and more angular, and might be taken for a sulcate variety of *A. cuneiformis* Conrad.

Astarte (Ashtarotha) distans Conrad.

Astarte distans Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 288, 1862, and 578, 1863; Am. Journ. Conch., ii., p. 72, pl. iv., fig. 14, 1866; Whitfield, Mio. Moll. N. Jer., p. 53, pl. vii., figs. 13–17, 1895.

Miocene marl of Cumberland County, New Jersey, at Shiloh and Jericho; Conrad and Burns.

Smaller, more equilateral, and with more erect beaks than *undulata* and somewhat more compressed.

Astarte (distans var.?) floridana Dall.

PLATE 57, FIGURE 19.

Chesapeake Miocene horizon at Alum Bluff and Bailey, Calhoun County, Florida; Burns and Vaughan.

Shell subtriangular with acute, slightly prosogyrate beaks, compressed, subrostrate, with a few wide ripples near the umbones, the ventral half of the disk, or more, smooth; lunule and escutcheon narrow, elongate, smooth, the former deeply excavated. Height 23, length 25, diameter 9 mm.

This shell recalls *undulata,* but has not the high, gibbous beaks and is a smaller and flatter species; it differs from *distans* by its thick and heavy hinge, like that of *undulata,* its thicker shell, and more rostrate valves.

Astarte (Ashtarotha) parma n. sp.

PLATE 57, FIGURE 22.

Older Miocene of Skipton, Maryland, and the *Isocardia* bed at Plum Point; Harris and Burns.

Shell very flatly compressed, inequilateral, rostrate, the beaks at the anterior third low, acutely pointed, slightly recurved; lunule narrow, deeper than wide; escutcheon narrow, deep, as long as the posterior slope, which is almost straight; sculpture of the beaks with about five small, fine ribs, close together, followed by three or four very distant, much wider ripples, obsolete towards the ends and ventral margin, with a few irregularly spaced linear concentric sulci beyond; posterior dorsal profile slightly arcuate, basal margin slightly emarginate behind; anterior end rounded, posterior end pointed; inner ventral margins crenate; hinge-plate broad and flat with two long, narrow cardinals in each valve. Height 25.0, length 28.5, diameter 7.0 mm.

This curious form differs from *perplana* by its more compressed, flatter, and more acutely pointed valves, and by its umbonal sculpture.

Astarte (Ashtarotha) perplana Conrad.

Astarte perplana Conrad, Fos. Medial Tert., p. 43, pl. xxi., fig. 3, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864; not *A. perplana* Conrad, 1841.

Miocene of Maryland at St. Mary's, Windmill Point, and Blake's Cliffs, Calvert County.

Smoother, more convex, and thicker than the preceding species.

Astarte (Ashtarotha) cuneiformis Conrad.

Astarte cuneiformis Conrad, Fos. Medial Tert., p. 42, pl. xx., fig. 9, 1840; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Astarte varians Conrad, Proc. Acad. Nat. Sci. Phila., i., p. 29, 1841; Journ. Acad. Nat. Sci. Phila., viii., p. 184, 1842; Bull. Nat'l Inst. No. 2, p. 181, 1842; Fos. Medial Tert., p. 67, pl. xxxvii., fig. 7, 1845; Proc. Acad. Nat. Sci. Phila., xiv., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

?Astarte planulata Conrad, Bull. Nat. Inst., ii., p. 187, 1842; Proc. Acad. Nat. Sci. Phila., p. 578, 1863; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864 (a nude name, nowhere defined).

Miocene of Plum Point, Maryland, upper and lower layers, and various localities within a mile of Plum Point.

More elongated and inequilateral than the *A. perplana* and with a shorter lunule. The sculpture is very variable, the type has the umbones rippled and the remainder of the disk smooth and rather flat; the variety *obesa* Dall is thicker and more convex, with the umbones not flattened and the whole surface perfectly smooth; the variety *calvertensis* Glenn is compressed like the type, but finely concentrically striated all over.

The Pliocene, being an epoch of relatively high sea temperature in which the subtropical fauna made inroads on the territory previously occupied by the cooler-water Miocene, has few *Astartes* and they are of small or deep-water types.

Astarte meridionalis Gabb.

Astarte meridionalis Gabb, Journ. Acad. Nat. Sci. Phila., 2d Ser., viii., p. 376, pl. xlvii., fig. 78, 1881.

Pliocene clays of Limon, Costa Rica, Gabb.

Three millimetres long, concentrically ribbed, trigonal, and pointed behind.

Astarte opulentora n. sp.

Plate 57, Figure 11.

Pliocene clays of the Tehuantepec Railway, seventy and one hundred and twenty-four kilometres west of Atlantic terminus; J. W. Spencer.

Shell small, rounded, wide and rounded behind, shorter and more pointed in front; beaks small, low, usually eroded; lunule short, lanceolate, slightly impressed; escutcheon longer, narrow, bordered by a low keel externally; valves moderately convex, rounded below, sculptured with small, subequal, low, concentric ribs and channels, which are less distinct near the posterior margin; hinge normal; hinge-plate narrow, inner margins sharply crenulated. Height 10.0, length 12.5, diameter 6.5 mm.

This species is related to *Astarte lens* of Stimpson and *A. nana* Jeffreys of the recent fauna, but seems sufficiently distinct. The formation from which these and some other extremely interesting fossils were obtained was named by Dr. Spencer the Coatzocoalcos formation, and its fauna is intimately related to that found in two hundred to four hundred fathoms in Florida Strait or off the coast of Cuba. The present species was at first identified with *Astarte Smithii* Dall, but subsequent study shows it to be a larger species with narrow furrows between wider concentric ribs, the furrows having a V section, while in *A. Smithii* the furrows are wider than the ribs and have a flat bottom or channelled section.

With the advent of the glacial period, the sea along the eastern coast appears to have been cooled, so that many of the Pliocene forms retreated or became extinct, and coincidently an incursion of cold water forms from the north altered the character of the fauna. Among these northern species were quite a number of *Astartes,* and, as the nomenclature of this group has been very much confused, it seems desirable to briefly review these forms, most of which are still found living in boreal or Arctic waters. This task is much facilitated by the excellent "Observations on the Genus *Astarte* with a List of the Recent Species" published by Mr. E. A. Smith, of the British Museum, in the "Journal of Conchology," volume iii., pp. 196–232, 1881. A few species have since been added and a few names changed, but, with these exceptions, for the nomenclature of the species of this puzzling group we can hardly do better than accept Mr. Smith's laborious determinations as far as they are available. The important point is to correlate the names used by authors for these Pleistocene fossils with the proper names as determined by Mr. Smith, except in a few cases where the possession of a large series of American species or the progress of science since 1881 has enabled us to note progress in the determination of points at that time in doubt. These have been brought up to date in my recent "Synopsis of the Astartidæ with a Review of the American Species," to which the reader is referred for fuller details.

Astarte laurentiana Lyell.

A. laurentiana Lyell, Travels in N. Am., London, 1845; American edition, vol. ii., pp. 125–6, figs. 15a–c, 1845; Dawson, Post-Pl. Geol. Canada, p. 75, pl. vii., fig. 2, 1872, The Canadian Ice Age, p. 235, pl. i., fig. 2, 1893; Whiteaves, Cat. Marine Inv. of Eastern Canada, p. 134, 1901.

Post-Pliocene: Leda clays of Montreal and other localities in the St. Lawrence valley and at Beauport and Rivière du Loup.

I agree with Dr. Whiteaves, of the Canadian Geological Survey, that this Pleistocene species is not exactly represented by any recent form of the region and have applied to the recent shell, which has usually been called *laurentiana,* the specific name of *soror.* The present species is the only one I have seen which is peculiar to the east American Pleistocene beds, the others found in them being also known in the recent state.

Astarte striata Leach, better known as *A. Banksii* of authors but not of Leach, is reported as abundant in the Pleistocene of Portland, Maine; the St. Lawrence valley; St. John, New Brunswick; Labrador, and Greenland.

Astarte elliptica Brown, *A. arctica* Gray, *A. borealis* Schumacher, on the eastern coast, and *A. arctica* Gray, *A. borealis* Schumacher, and *A. alaskensis* Dall, on the western coast of boreal America, occur in the various Pleistocene deposits and the last mentioned in the beds on Sucia Island, Gulf of Georgia. These are all boreal species, but *Astarte undata* Gould and *A. castanea* Say are reported from the Pleistocene of Point Shirley, Massachusetts; the latter also at Nantucket and the former at Gardiner's Island, near New York.

Subgenus GOODALLIA Turton.

Astarte (Goodallia?) americana n. sp.

Plate 56, Figure 5.

Eocene of the Claiborne sands, Claiborne, Alabama; L. C. Johnson.

Shell small, compressed, nuculoid in form, anterior slope short, directly descending, posterior longer, arcuate; base arcuate, beaks low, lunule lanceolate, impressed, escutcheon obscure; surface finely concentrically striated; hinge of left valve with two diverging cardinals, inner margins smooth. Length 4.0, height 3.25, diameter 1.5 mm.

A single, somewhat worn left valve is all that we possess of this species. The form is very different from that of the Parisian species, but the hinge appears to be the same, the anterior tooth having been broken off and only its base remaining. The pallial line is certainly unsinuated, and, taking all the circumstances into consideration, it seems probable that this species should be referred to *Goodallia,* though it has somewhat the aspect of a Leptonaceous shell.

Superfamily CYPRICARDIACEA.

Family PLEUROPHORIDÆ.

Genus **TRAPEZIUM** (Humphrey) Mühlfeld.

Trapezium (Anonymous) in Humphrey's Mus. Calonn., p. 50, 1797; Megerle von Mühlfeld, Ent. Neuen. Syst. Mag. d. Ges. Naturf. Freunde zu Berlin, v., p. 68, 1811.

Libitina Schumacher, Essai, p. 168, 1817, type *Chama oblonga* Linné; Fischer, Man., p. 1074, 1887.

Cypricardia Lamarck, An. s. Vert., vi., pt. i., p. 27, 1819; ed. Deshayes, vi., p. 437, 1835; Blainville, Man. Mal., p. 541, 1825.

Trapezium (Megerle) Gray, P. Z. S., 1847, p. 194.

The genus *Trapezium* was proposed in Humphrey's anonymous sale catalogue for a heterogeneous group which was called the "square cockles" and which included *Chama oblonga* Linné. Megerle restricted the genus and divided it into two sections, the first typified by *Chama oblonga,* or *guinaica,* and *C. angulata* Lam., the second including a form which had already been named *Gastrochæna* by Spengler (1783). Schumacher's *Libitina* and *Cypricardia* Lamarck were both typified by the species which had been cited by Megerle, and which is most commonly known by Lamarck's name of *Cypricardia guinaica.* This was Schumacher's only species and Lamarck's first species, and was taken to illustrate *Cypricardia* by Bowdich in 1822 and Blainville in 1825. There can be no question as to Megerle's right to select a type from Humphrey's list to bear the generic name, and also that of the forms specified by Megerle, only the *Chama oblonga* is found in Humphrey's list. Therefore the right of *Trapezium* to adoption stands on a solid foundation.

Trapezium has short, papillose siphons and an entire pallial line, a small byssiferous foot, the lobes of the mantle largely united, and the adductors composed of two groups of fibres, partially separated. The shell is trapezoidal, with the inner margins smooth; the ligament, inserted in a narrow groove, is elongated and external, the beaks very near the anterior end of the shell. The sculpture is chiefly concentric. There are three divergent cardinals in each valve, the posterior right cardinal usually bifid, the two anterior left cardinals united above. The left lateral is long and strong, received between two laminæ of the right valve. There are no anterior laterals. *Trapezium* makes its appearance in the Mesozoic. Well-characterized species appear in the Eocene.

The genus *Coralliophaga,* which bores in coral and other limy substances, is much like *Lithophagus* in form, radially striated, has the teeth much compressed and slender, only two instead of three cardinals and one lateral in each valve, with a faint sinuation of the pallial line.

Oryctomya has the form of *Coralliophaga,* but the surface is covered with very fine radial lines of minute granulations, as in *Eucharis,* with one slender almost linear posterior cardinal tooth on the nymph and anteriorly another short and pedunculate, more or less bifid, in each valve; there is an obscure ventral projection of the hinge-plate in the left valve in front of the cardinals,

but there are no lateral teeth. There is a short, wide, angular pallial sinus, more emphatic than in *Coralliophaga,* and in senile specimens this is radially striated. The known species are Eocene.

Trapezium claibornense Dall.

PLATE 43, FIGURES 9, 10.

Trapezium claibornense Dall, Trans. Wagner Inst., iii., pt. v., p. 1199, pl. xliii., figs. 9, 10, 1900.

Claiborne sands at Claiborne, Alabama.

Shell small, subquadrate, subcompressed, inequilateral, with low, pointed beaks at the anterior third; the anterior end rounded and rather attenuated, the posterior broad and subtruncate; disk covered with rather close, rounded, concentric ribbing, obsolete on the umbones; hinge feeble, the teeth imperfectly developed, the cardinals obscure and the lateral feeble; the pallial line entire. Length 7.0, height 4.5, diameter 2.0 mm.

This shell is evidently young and only the left valve was obtained. It is, however, evidently a *Trapezium,* and of interest as showing the presence of that genus in the Claiborne sands.

To the typical *Trapezium* Lamarck united another form subsequently separated by Blainville.

Genus **CORALLIOPHAGA** Blainville.

Coralliophaga Blainville, Man. Mal., p. 560, 1825.
Lithophagella Gray (MS.?) *fide* H. and A. Adams, 1857.
Cypricardia (sp.) Lamarck, 1819.

The type is:

Coralliophaga coralliophaga Gmelin.

Chama coralliophaga Chemnitz, Conch. Cab., x., p. 359, pl. clxxii., figs. 1673–4, 1788.
Chama coralliophaga Gmelin, Syst. Nat., p. 3305, No. 25, 1792.
Cardita dactylus Bruguière, Dict. Sci. Nat. No. 13, p. 412; Encyc. Méth., pl. ccxxxiv., figs. 5a–b.
Cypricardia coralliophaga Lam., An. s. Vert., vi., p. 28, 1819.
Coralliophaga carditoidea Blainville, Man. Mal., p. 560, pl. lxxvi., fig. 3, 1825; Reeve, Conch. Icon., pl. ii., fig. 12.
Petricola carditoidea Sowerby, Conch. Man., p. 295, fig. xcii., 1842.
Cypricardia Hornbeckiana Orbigny, Moll. Cubana, ii., p. 266, pl. xxvi., figs. 33, 34, 1846.
Cypricardia gracilis Shuttleworth, Journ. de Conchyl., v., p. 150, 1856.

Pliocene of the Caloosahatchie River, Florida, Dall and Griffith; Pleisto-

cene of the West Indies and Curaçao; recent from Cedar Keys, Florida, south to the north coast of South America, including Cuba, St. Domingo, Guadeloupe, St. Thomas, etc., and also at Bermuda.

This species is easily recognized by its radial sculpture. It is found in borings in coral and limestone rock, which appear in many cases to have been originally made by *Lithophaga* or other borers. In such cases the *Coralliophaga* is apt to take the elongated subcylindric form of the precursor. In other cases it may be that the occupant is wholly the artificer of the cavity.

Coralliophaga elegantula Dall.

PLATE 25, FIGURES 2, 2a.

Coralliophaga elegans Dall, Trans. Wagner Inst., iii., p. 920, pl. xxv., figs. 2, 2a, 1898; not of Deshayes, Coq. Fos. bass. Paris, 1824.

Upper Oligocene of the Chipola marl, Chipola River, Florida, and of the silex beds of Ballast Point, Tampa Bay; Burns and Crosby.

Shell ovate, as figured; thin, sculptured only by faint incremental lines; interior filled with a hard matrix by which it is obscured. Alt. 11.5, lat. 19.5, diam. 7.0 mm.

This species somewhat recalls the *C. lithophagella* Lamarck, of the Mediterranean, but is of more elegant shape. From any other American species it can be distinguished by its smooth surface. The specific name first chosen cannot be retained, as it has already been used for different fossil species by Defrance, Deshayes, and others.

Genus **ORYCTOMYA** Dall.

Oryctomya Dall, Nautilus, xi., p. 135, April, 1898; Trans. Wagner Inst., iii., p. 929, pl. xxxiv., fig. 16, 1898.

Coralliophaga Clark, Bull. U. S. Geol. Survey No. 141, p. 73, 1896; Harr., Bull. Pal., ii., p. 252, 1897.

This group was originally proposed by me as a subgenus of *Coralliophaga,* but further study of the latter group leads me to believe that the two forms are generically distinct. The type is the following species:

Oryctomya claibornensis Dall.

PLATE 34, FIGURES 16, 16a.

Oryctomya claibornensis Dall, Nautilus, xi., p. 135, April, 1898; Trans. Wagner Inst., iii., p. 929, pl. xxxiv., figs. 16, 16a, 1898.

Claiborne sands at Claiborne, Alabama; Burns.

Two other forms have been described which are referable to this genus, though possibly not distinct from each other. *Coralliophaga Bryani* Clark, Bull. U. S. Nat. Mus. No. 141, p. 73, pl. xv., figs. 2a–b, 1896, from Pamunkey Neck, Virginia, should, strictly speaking, be called *O. Briani,* since the collector for whom it was named spelled his name in this fashion; it is a shorter, higher, and more equilateral shell than the Claiborne species, but appears to agree better with *Coralliophaga prima* Harris, Bull. Pal., ii., p. 252, pl. xiii., figs. 4, 4a, 5, 1897. The latter is from the Chickasawan or Lignitic Eocene of Hatchetigbee Bluff, Alabama, and may also, according to Professor Harris, be found at Wood's Bluff.

The *Coralliophaga arata* of Conrad (Fos. Tert. Form., p. 20, pl. v., fig. 1) is a species of *Carditamera.* The *Cypricardia pedroana* of Cooper (Bull. Cal. State Mining Bureau, No. 4, p. 25, 1894) is probably a *Calyptogena;* it is from the Neocene of Los Angeles, California. The original *Petricola pedroana* of Conrad (Pac. R. R. Reps., v., p. 324, pl. iii., fig. 24, 1856), which by some inadvertence has been identified with the former, is almost certainly only an imperfect specimen of *Venerupis lamellifera* Conrad.

The above comprise all the American Tertiary species which I have been able to find referred to this general group.

So far as known *Trapezium* and *Coralliophaga* are not represented in the recent fauna of the west coast of America, the *californicum* Conrad being an Indo-Pacific shell described as Californian by an error of labels.

Genus **CYCLAS** (Bruguière) Link.

Cardia (sp.) Olafsen und Povelsen, Reise durch Island, German edition, ii., p. 216, pl. xi., fig. 8 (1772), 1775 (not binomial).

Venus (sp.) Linné, Syst. Nat., ed. xii., p. 1131, 1767 (*V. islandica*).

Pectunculus (sp.) Da Costa, Brit. Conch., 183, 1778 (*P. crassus*).

Cyclas (sp.) Bruguière, Encyc. Méth., 3me livr., pl. ccci., figs. 1, 17, 1798 (1st species *Venus islandica* L.).

Cyclas Link, Beschr. Rostock Samml., 150, 1807; sole ex. *Venus islandica* (L.) Gmelin (not of Lamarck, 1799).

Cyprine Lamarck, Extr. d'un Cours Zool., p. 107, 1812 (nude vernacular name without type or diagnosis).

Arctica Schumacher, Essai, p. 145, 1817; Mörch, Cat. Yoldi, ii., p. 38, 1853; Newton, Olig. Fos. Brit. Mus., p. 295, 1891.

Cyprina Lamarck, An. s. Vert., v., p. 556 *bis,* 1818; Hoyle, Journ. Conch., x., p. 214, 1902.

Armida Gistel, Naturg. Thierr., p. 172, 1848; not of Risso, 1826, *Isopoda.*

Asmidia Mörch, Cat. Yoldi, ii., p. 38, 1853 (in synon.); H. and A. Adams, Gen. Rec. Moll., ii., p. 444, 1857 (err. typ. for *Armida* Gistel).

Cypriniadea Rovereto, Ill. Moll. Tongr., Atte R. Univ. Genova, xv., p. 96, 1900; Newton, Journ. Conch., x., p. 196, 1902.

The recent shell which forms the type of this genus was imperfectly known to the earlier authors, confused with *Veneridæ, Cardia,* and other groups, and by many, on account of its conspicuous brownish periostracum, suspected to be a fluviatile shell. Bruguière figured it on his plates of the "Encyclopédie Méthodique," where it forms the first and most conspicuous figure of those devoted to his genus *Cyclas.** The species represented on these two plates are as follows, according to Lamarck and Bory St. Vincent, who edited them: plate ccci., fig. 1, *Venus islandica* (L.) Gmelin; fig. 2, (*Corbicula*) *fuscata* Lamarck, var.; fig. 3, (*Cyrena*) *cyrænopsis* Valenciennes; plate cccii., fig. 1, (*Corbicula*) sp.; fig. 2, (*Corbicula*) *fuscata* Lamarck, typical; fig. 3, (*Astarte*) *borealis* Gmelin; fig. 4, (*Cyrena*) *zeylanica* Lamarck; fig. 5, (*Sphærium*) *rivicola* Lamarck; fig. 6, (*Sphærium*) *calyculata* Draparnaud. I have put in parentheses the modern current generic names belonging to the species. Out of this series the type of *Cyclas* s. s. must be selected. Now the genus *Sphærium,* including the last two species, had been proposed twenty years before by Scopoli, hence these are not available for the purpose, and Lamarck's use in 1799 of a species not included in the list could not, by the laws of nomenclature, be accepted as allowable. The first writer to restrict the genus was Link, who in 1807 selected *Cyclas islandica,* the first, largest, and most conspicuous of Bruguière's species, to represent the genus, putting the last species of *Sphærium* in a genus *Musculium* Link, which, of course, takes precedence of *Calyculina* Clessin, 1871. The next elimination was that of Megerle von Mühlfeld, who established his genus *Corbicula* on the second species of Bruguière, which is, according to Dillwyn, identical with *Tellina fluminalis* of Gmelin. The introduction of the name *Astarte* by J. Sowerby in 1816 covered the single species on plate cccii.; and Lamarck, by proposing the genus *Cyrena* in 1818, completed the task of providing the species of the original list with generic names.

The fate of the synonyms *Cyprina, Crassina, Arctica, Armida,* etc., seems clearly fixed; they must retire from the nomenclature in spite of the fact that some of them have been widely used. The early use of *Cyclas* in the sense of the earlier *Sphærium* is to be regretted, since it is so familiar, but it in no way invalidates the proper application of Bruguière's name, according to the rules

* Troisiéme livraison, pls. ccci., cccii., published in 1798, *not* 1792 as generally cited.

of nomenclature as above set forth. It is always disagreeable to use a familiar name in an unfamiliar sense, but, luckily, the use of *Sphærium* for the Lamarckian *Cyclas* is now universal, and the unwarranted resuscitation of the non-Linnean *Cyclas* of Klein by Mörch in 1853 has found few advocates, so the students of the present generation will be less annoyed by the present necessary change in the use of this name.

Cyclas islandica is only known in the fossil state in America from the raised beaches of the boreal region of late Pleistocene age, but allied species appear in the Crag of Iceland. The recent shell extends in cold water from the Arctic Atlantic to Cape Hatteras, North Carolina, in six to two hundred and sixty-four fathoms. It is not circumboreal.

Genus **EULOXA** Conrad.

Euloxa Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 578, 585, 1863; xxiv., p. 52, pl. i., fig. 5, 1872; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Shell subovate, truncate behind, with a wide, shallow sulcus extending from the beaks to the sulcation, bounded on each side by a rather obtuse keel; surface concentrically sculptured; dorsal areas feebly impressed but without defined lunule or escutcheon; inner margins smooth, pallial line entire; hinge with three cardinals in the left valve, the middle one largest, the posterior dorsal valve margin bevelled so as to enter a shallow groove in the margin of the opposite valve; right valve with two cardinals, the anterior entire, triangular, the posterior elongate and bifid; ligament external, inserted on nymphs. Dental formula $\frac{\text{L. } 1.10101.}{\text{R. } 0.01010.}$. Type *Venus latisulcata* Conrad. Miocene.

Euloxa latisulcata Conrad.

Venus latisulcata Conrad, Fos. Medial Tert., p. 40, pl. xx., fig. 6, 1840.

Astarte latisulcata Orbigny, Prodrome Pal., iii., p. 112, No. 2089, 1857.

Euloxa latisulcata Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 578, 585, 1863; xxiv., p. 52, pl. i., fig. 5, 1872; Meek, Checkl. Inv. Fos. Miocene, p. 7, 1864.

Miocene of Middlesex County, near Urbana, Virginia; Conrad.

This apparently is a rare species, as I have seen only the types in the Philadelphia Academy's collection, which were courteously loaned me for study. The genus, which has been referred to the *Veneridæ* and *Astartidæ*, is a Cyprinoid, in which the posterior laterals have become obsolete, being clearly defined only in the young or adolescent shell.

Order ANOMALODESMACEA.

Superfamily POROMYACEA.

Family CUSPIDARIIDÆ.

Genus **CUSPIDARIA** Nardo.

Ryderia Wilton, Quart. Phil. Journ., 1830, p. 73. No type named.

Cuspidaria Nardo, Revue Zool., p. 30, 1840; Dall, Bull. Mus. Comp. Zool., xii., p. 292, Sept., 1886; Proc. U. S. Nat. Mus., xii., p. 279, 1889. Type *Tellina cuspidata* Olivi.

Neæra Gray, Griffith's Cuvier, legend to plate xxii., fig. 5, 1833 (the volume dated 1834), type *N. chinensis* Gray in Index, p. 598; Gray, Synopsis Brit. Mus., 1840, *fide* Gray in P. Z. S., 1847, p. 192.

Not *Neæra* Robineau Desvoidy, 1830, *Diptera*.

This group has been fully discussed in the two papers of mine above referred to, while the anatomy has also been more fully inquired into by Thiele and Ridewood.

The subdivisions adopted in this family are as follows:

Genus *Cuspidaria* Nardo. Type *C. cuspidata* (Olivi).

Siphons elongate; valves with a resiliifer and one or more teeth in the hinge.

Subgenus *Cuspidaria* s. s.

Valves smooth or concentrically feebly sculptured, fossette posteriorly inclined and attached to the hinge-margin by its posterior edge; one posterior lateral tooth in the right valve.

Subgenus *Cardiomya* A. Adams, 1864. Type *Neæra Gouldiana* Hinds.

Valves with radiating sculpture, and the fossette more vertical and prominent; otherwise like *Cuspidaria* s. s.

Subgenus *Leiomya* A. Adams, 1864. Type *Neæra adunca* Gould, not Smith.

Surface as in *Cuspidaria* s. s.; hinge with an anterior cardinal in each valve, anterior and posterior laterals in the right valve, left valve without developed laterals; fossette as in *Cuspidaria* s. s.

Subgenus *Pseudoneæra* Sturany, 1900. Type *P. thaumasia* Sturany. Red Sea.

Shell resembling *Leiomya* in form, the hinge with, in the right valve, two prominent projecting laminæ, one in front and one behind, the small and shallow fossette recalling the diverging laminæ of *Rochefortia* but more prominent

and free; in the left valve a small, obscure denticle in front of the fossette; the rostrum short and pointed, the surface feebly concentrically striated.

Subgenus *Bowdenia* Dall, 1903. Type *C. distira* Dall.

Sculpture like *Cardiomya;* hinge with a posterior left and anterior right cardinal, the resilium between them, but no laterals; the margins of the right valve grooved to receive the edges of the valve opposite.

Subgenus *Vulcanomya* Dall, 1886. Type *V. Smithii* Dall, = *Neæra adunca* Smith, not Gould.

Surface concentrically sculptured; hinge with no cardinal teeth, a small, thickish anterior and posterior lateral in the right valve and a similar anterior lateral (only) in the left valve, with a small, central fossette.

Subgenus *Luzonia* Dall and Smith, 1889. Type *Neæra philippinensis* Hinds, not A. Adams.

Surface concentrically striated; hinge without laterals or left cardinals; right valve with an anterior cardinal, the fossette narrow, parallel with the cardinal margin under the apex.

Subgenus *Plectodon* Carpenter, 1864. Type *P. scaber* Carpenter.

Surface granular, as in *Poromya;* hinge as in *Leiomya,* but having a tooth-like prominence (rather than a real tooth) upon the margin, formed by the spiral twisting under the beaks of the hinge-margin itself, upon and over which in *P. scaber* there is a nearly obsolete external ligament; the resilium is inserted behind and under the beaks rather than in a projecting fossette or on the hinge-margin; the tips of the siphons protected by a leathery ring, flattened and broadened at the sides, analogous to the siphonal shields of *Tresus.*

Subgenus *Rhinoclama* Dall and Smith, 1886. Type *Neæra philippinensis* A. Adams, not Hinds. *Rhinomya* A. Adams, not Robineau Desvoidy, is synonymous.

Resembling *Plectodon,* but without cardinal teeth and the surface concentrically striate without granules.

Subgenus *Tropidomya* Dall and Smith, 1886. Type *Neæra abbreviata* Forbes. *Tropidophora* Jeffreys, not Troschel or Thompson, is synonymous.

Surface and resilium as in *Leiomya;* no lateral teeth, but an anterior cardinal in each valve.

Genus *Halonympha* Dall and Smith, 1886. Type *Neæra claviculata* Dall.

Surface concentrically striate or smooth; hinge with an acute cardinal in the right valve, no other teeth in either valve; the posterior hinge-margin is buttressed by a long, sharp, clavicular lamina in both valves; the fossette small and central.

The clavicle in this group receives the posterior adductor on its upper surface, thus serving as a myophore as well as a buttress.

Genus *Myonera* Dall and Smith, 1886. Type *Neæra paucistriata* Dall.

Surface with radiating or concentric sculpture or both; hinge edentulous; fossette vertical or posteriorly directed, adherent by either margin.

The value of the above groups may eventually be raised somewhat in several cases. Professor Verrill has suggested generic rank for *Cardiomya,* though this seems doubtful to me. Further information in regard to the very peculiar anatomy of these forms is necessary before any final systematic arrangement can be reached. In a general way recent *Cardiomya* seems to affect warm and relatively shallow waters, the smooth *Cuspidaria* being found in colder, deep, or northern waters.

A fossil species of *Cuspidaria* was figured by Wilton in 1830, and the name *Ryderia* proposed for it, but the species was not described or specifically named, and I have not been able to find any other data in regard to it beyond the references in Bronn and Herrmannsen. The group is known from rocks as early as the Upper Jurassic, and *Cardiomya* was already differentiated in the later Cretaceous.

Our earliest Tertiary *Cuspidaria* (s. s.) is *C. æquivalvis* Whitfield, from the Shark River, New Jersey, Eocene. The next, of nearly the same age, is a species named *alternata* by Meyer and Aldrich from the Eocene of Lisbon, Alabama; there was, however, an earlier species of this name (*Neæra alternata* (Orb.) Gabb), and it will best take the name of *C. attenuata,* by which it is designated in the explanation to Mr. Aldrich's plate. The *Neæra? nasutoides* of Whitfield, 1885, is imperfectly known; judging from the figures, it does not belong in this family.

Nearly all the other fossil species of this genus in our Tertiary belong to the subgenus or section *Cardiomya. C. prima* Aldrich, from the Wood's Bluff horizon, has the look of a *Myonera,* but may be left where it is until the hinge is described. *C. dolabriformis* Gabb appears in the Eocene of California, but is imperfectly known. *C. multiornata* Meyer and Aldrich, from Wahtubbee

horizon, though described from a fragment, is probably a *Cardiomya*. The following species will be treated a little more at length:

Cuspidaria (Cardiomya) craspedonia n. sp.

PLATE 57, FIGURE 17.

Oligocene of the Bowden, Jamaica, marls; Henderson and Simpson.

Shell small, plump, rostrate, the disk sculptured with numerous elevated, simple, radial threads, with, in the interspaces, from one to three much finer subequal threads, the whole crossed by fine concentric lines of growth; the major radials increase somewhat in prominence near the posterior end; beaks low, submedian, inconspicuous; rostrum small, short, slightly recurved, subtruncate terminally, sculptured concentrically, with a single feeble thread extending from the beaks to the lower posterior extremity; hinge normal, fossette very small; interior basal margin fringed by small projections corresponding to the major radial sculpture. Length 4.0, height 2.5, diameter 2.0 mm.

This species is probably the one referred by Guppy to *C. alternata* Orbigny, a recent form which it resembles, but which is larger and has the rostrum radially sculptured with numerous threads.

Cuspidaria (Bowdenia) distira n. sp.

PLATE 57, FIGURE 16.

Oligocene marl of Bowden, Jamaica; Henderson and Simpson.

Shell small, plump, with elevated beaks nearly centrally situated, attenuated, rostrate, and compressed behind; sculptured with two strong threads, one on the anterior dorsal slope and the other near the posterior border of the disk, which by its projection angulates the basal margin; between these two the surface is finely, radially striate, and a few nearly obsolete striations occur behind the posterior thread; rostrum compressed, straight or a little decurved, nearly smooth, a few faint radial striæ on its dorsal aspect, rounded terminally; hinge as described in the diagnosis of the subgenus; basal margin entire except where the radial thread forms a small projection. Length 3, height 2, diameter 2 mm.

This little shell recalls *Luzonia monosteira* of the recent fauna, but has a different hinge.

Cuspidaria (Cardiomya) ornatissima Orbigny.

Sphena ornatissima Orbigny, Moll. Cuba., ii., p. 286, 1846; atlas, pl. xxvii., figs. 13–16, 1845.

Neæra costata Bush, Trans. Conn. Acad., vi., p. 472, pl. xlv., fig. 21, 1885; Rep. U. S. Com. Fisheries for 1883, p. 85, 1885; not of Sowerby, 1834.

Cuspidaria (*Cardiomya*) *ornatissima* Dall, Blake Report, part i., p. 296, 1886; Bull. U. S. Nat. Mus., No. 37, p. 66, No. 420, pl. xli., fig. 21, 1889.

Cardiomya glypta Bush, Proc. U. S. Nat. Mus., xx., p. 810, pl. lxxi., fig. 1, lxxvi., figs. 3, 7, 1898.

Pliocene marls of the Caloosahatchie and Shell Creek, Florida, Dall and Burns; living from Cape Hatteras, North Carolina, southward to Cuba and Guadeloupe in two to one hundred and twenty-four fathoms.

This is the most abundant species of our recent fauna and very variable as regards the radial sculpture and to some extent also varying in convexity and form. The major radials are crenulate and slightly flattened above; finer radial threads may appear in the interspaces and sometimes nearly reach the strength of the others; there are usually five to eight major radials, the minor ones may be few or reach ten or twelve in number; the rostrum may have two or three faint threads or be almost smooth. Orbigny's figures are taken from half-grown specimens, yet one is figured as having eight ribs on one valve and thirteen on the other in the same individual. No characters having been indicated by which they can be constantly differentiated, I have no hesitation in uniting Miss Bush's species with that of Orbigny.

Cuspidaria (**Plectodon**) **granulata** Dall.

Neæra granulata Dall, Bull. Mus. Comp. Zool., ix., p. 111, 1881.

Leiomya (*Plectodon*) *granulata* Dall, Bull. Mus. Comp. Zool., xviii., p. 300, pl. iii., fig. 8, 1886; Dall, Bull. U. S. N. Mus. No. 37, p. 66, pl. iii., fig. 8, 1889.

Pliocene marls of the Caloosahatchie River, Florida, Dall, a single valve. Living from Cape Florida to Barbados in fifty-four to one hundred and eighteen fathoms.

FAMILY ———.

Genus **SPHENIOPSIS** Sandberger.

Spheniopsis Sandberger, Conch. Mainz. Tert. beck., p. 289, 1863; Stoliczka, Cret. Pelyc. India, p. 37, 1871; Tryon, Struct. and Syst. Conch., iii., p. 141, pl. cv., figs. 1–3 (*S. scalaris* Braun), 1884.

This peculiar little shell was described from the Oligocene of Germany and so far is known only from that epoch, the Pliocene *Neæra*, which Stoliczka compared with it, belonging to a different group. Heretofore this genus has not been known from America, and the specimens about to be described from

their external resemblance to *Cuspidaria* were placed with the latter genus and not discovered to be different until it was taken up for study. The group seems likely to belong in the *Corbulidæ*, but owing to the circumstances above noted it finds a place here.

Spheniopsis americana n. sp.

Plate 57, Figures 28, 29.

Oligocene of the Chipola River, Calhoun County, Florida; Burns.

Shell small, equivalve, rostrate; beaks small, pointed, subcentral; sculpture of a few, nearly concentric, relatively large waves, sometimes obsolete, and fine concentric striation; dorsal slopes steep, forming an angle of nearly ninety degrees at the umbones; the anterior end rounded, base arcuate, posterior end rostrate, slightly twisted, subtruncate terminally; hinge in the right valve of two diverging relatively strong lamellar teeth, between which is the resiliary pit and above which the margins are grooved to receive those of the opposite valve, which is edentulous; the fossette is subumbonal and not elevated; the muscular impressions are distinct, as is the pallial line, which has a short, wide, rounded sinus; the inner margins are entire. Length 3, height 2, diameter 1 mm.

The waves near the beaks are inconstant in strength and extent, but seldom cover more than a third of the disk.

Family POROMYACIDÆ.

Genus **POROMYA** Forbes.

Paranmya Forbes, Rep. Moll. Æg. Sea, p. 143, 1844.

Embla Lovèn, Ind. Moll. Scand., p. 46, 1846; Gray, P. Z. S., 1847, p. 193.

<*Poromya* Dall, Bull. Mus. Comp. Zool., xii., p. 280, 1886; Bull. U. S. Nat. Mus. No. 37, p. 68, 1889.

Type *Poromya anatinaides* Forbes, = *P. granulata* (Nyst) = *Corbula granulata* Nyst, 1839.

A single species of this group has been described from our Tertiary.

Poromya mississippiensis Meyer and Aldrich.

Paramya mississippiensis Meyer and Aldrich, Bericht Senckenb. Nat. Ges., 1887, p. 10, pl. ii., figs. 1, 1a, 1b.

Jacksonian Eocene of Jackson, Mississippi, and Garland Creek, Choctaw County, Alabama; Burns.

This is marvellously like the recent and typical species, but differs in having the small granules arranged quincunxially instead of in distinct radial series.

Poromya jamaicensis n. sp.

PLATE 56, FIGURE 23.

Oligocene marls of Bowden, Jamaica; Henderson and Simpson.

Shell small; hinge, interior, and surface sculpture like those of *P. granulata* Nyst, but differing from it by the absence of rostration at the posterior end, which is evenly rounded though more attenuated than the anterior end. Length 5.5, height 4.7, diameter 3.0 mm.

All the specimens found agree in small size, absence of rostration, and closeness of the granular surface sculpture, which is disposed in radial lines.

P. granulata has not yet been found in the Pliocene, but is not rare, living in the deeper waters off the coast. Adults average about ten millimetres in length.

FAMILY VERTICORDIIDÆ.

Genus **VERTICORDIA** Wood.

Verticordia (Wood MS.) Sowerby, Min. Conch., vii., p. 67, pl. DCXXXIX., 1844.

Verticordia (Wood MS.?) Gray, Synopsis Brit. Mus., 1842; nude name.

Hippagus Philippi, Moll. Siciliæ, ii., p. 42, 1844; Sowerby, Min. Conch., vii., p. 67, 1844; not of Lea, 1833.

Cryptodon (sp.) Wood, Ann. Mag. Nat. Hist., vi., p. 247, 1840; not of Turton, 1822.

Iphigenia O. G. Costa, Paleont. Regn. Napoli, p. 160, 1850; not of Schumacher, 1817.

Verticordia Seguenza, Journ. de Conchyl., viii., p. 286, 1860; Fischer, *op. cit.*, p. 295, 1860; Seguenza, Rendiconte R. Accad. delle Sci., p. 5, 1876; Dall, Bull. Mus. Comp. Zool., ix., p. 105, 1881; xii., p. 285, 1886.

Hippella Mörch, Malak. Blätt., vii., pp. 199–200, 1861. Type *H. hippagus* Mörch.

This group was fully discussed by me in the paper above cited, and to this the reader is referred for details. The sub-groups and their types comprised in this family are as follows:

Subgenus *Verticordia* s. s. Type *Cryptodon verticordia* Searles Wood, + *Hippagus cardiiformis* Sowerby.

Subgenus *Trigonulina* Orbigny, 1845. Type *T. ornata* Orbigny, 1845.

Trigoniluna Chenu, 1862, *Hippella* Mörch, 1861, and *Hippagus* (sp.) Adams and Reeve are synonymous.

Subgenus *Haliris* Dall, 1886. Type *Verticordia Fischeriana* Dall.

Genus *Pecchiolia* Meneghini, 1851. Type *P. argentea* Mariti. Miocene.

Genus *Euciroa* Dall, 1881. Type *E. elegantissima* Dall.

For a full description of this remarkable type see Proc. U. S. Nat. Mus., xvii., No. 1032, pp. 687–697, 1895.

Genus *Halicardia* Dall, 1895. Type *Mytilimeria flexuosa* Verrill and Smith.

For full description see Proc. U. S. Nat. Mus., xvii., No. 1032, pp. 697–703, 1895.

Genus *Lyonsiella* Sars, 1872 (+ *Lævicordia* Seguenza, 1876). Type *L. abyssicola* Sars.

Genus *Mytilimeria* Conrad, 1838. Type *M. Nuttallii* Conrad.

Up to the present time only two species of *Verticordia* were known from our Tertiaries; the first was discovered by Emmons in 1858 and the second by Langdon in 1886. Owing to their rarity some confusion has prevailed with regard to these species which I have endeavored to clear up, at the same time adding a number of new species to the list.

Verticordia eocenensis Langdon (em.).

PLATE 42, FIGURES 13, 14.

Verticordia eocensis Langdon, Am. Journ. Sci., xxxi., p. 208, March, 1886; Aldrich, Bull. Ala. Geol. Survey No. 1, p. 40, pl. vi., fig. 13, 1886; Vaughan, Bull. U. S. Geol. Surv. No. 142, p. 46, 1896.

Verticordia eocense? Harris, Bull. Pal., i., p. 185, pl: vi., fig. 16, 1896.

Midway Eocene of Wilcox County, Alabama, Harris; lower Claibornian of Louisiana at St. Maurice, Vaughan; Claiborne sands below the *Scutella* bed at Claiborne, Alabama, Langdon and Schuchert; Wahtubbee Hills, Clarke County, Mississippi, Burns; Jacksonian of Montgomery, Louisiana, Vaughan.

This belongs to the typical section of the group and has from thirteen to sixteen ribs, a minutely granulose surface, moderately convex valves, and is well figured by Aldrich as above noted. The interspaces between the ribs usually show one or two impressed lines radiating in harmony with the ribs. The pallial line has a distinct but shallow sinuation.

Since the above was written Aldrich has described and figured (Nautilus, xvi., p. 100, Jan., 1903) *Verticordia Dalliana* from the Eocene of Alabama and *V. sotoensis* (*op. cit.*) from the Claibornian of De Soto, Mississippi. Both are rather near *V. eocenensis*.

Verticordia (Haliris) mississippiensis Dall.

PLATE 42, FIGURE 1.

Verticordia (Haliris) mississippiensis Dall, Trans. Wagner Inst., iii., p. 1198, pl. xlii., fig. 1, 1900.

Eocene of the Wahtubbee Hills, Clarke County, Mississippi; Burns.

Shell rounded triangular, inflated, with very high involute prosocœlous beaks; sculptured with about thirty-three narrow, angular radial ribs, uniformly distributed and with about equal interspaces, the entire surface closely and minutely granulose; the granules are more or less arranged in radial lines; basal margin arcuate, produced towards the middle, serrate by the sculpture, nymphs strong; interior brilliantly pearly and very much disposed to scale off. Lon. 5.5, alt. 5.0, diam. about 6.0 mm.

This shell, external, looks like a minute *Pecchiolia*. The pearly substance is so friable that it is hardly safe to attempt to describe the hinge, all the specimens being more or less defective. There is no lunule. The shell is much heavier than the Bowden species and more pearly.

Verticordia sp. indet.

Eocene of Wood's Bluff, Alabama; Burns.

This species is clearly different from any of the others, but is represented only by a single worn right valve in the collection. It has sixteen rather low, close ribs, uniformly distributed and covered with a marked granulation. The ribs are closer and wider than in *V. eocenensis* and the interspaces correspondingly narrower. It has the aspect of an *Haliris* rather than a typical *Verticordia*.

Aldrich in his paper in the "Nautilus" (Jan., 1903, p. 101, pl. iv., figs. 22, 23) has described and figured *Verticordia* (*Haliris*) *quadrangularis* from the Eocene of Alabama. It is said to have fewer and more rounded ribs and a more depressed lunular area than *V. mississippiensis*.

Verticordia (**Haliris**) **jamaicensis** n. sp.

Oligocene of the Bowden marl, Jamaica; Henderson and Simpson.

Shell small, thin, subquadrate, inflated, with strongly prosocœlous beaks; sculptured with about twenty-seven radial close-set ribs with narrower interspaces; a smooth, deep lunular impression in front of, and a narrow, escutcheon-like, smooth area behind them, the whole surface minutely granulose; basal margin angularly produced near the middle, internally minutely fluted in harmony with the ribs; hinge normal. Alt. 4.75, lon. 4.5, diam. 4.6 mm.

This has a general resemblance to *V. mississippiensis*, but is smaller, thinner, proportionately shorter, and more inflated.

Verticordia (**Trigonulina**) sp. indet.

Vicksburgian Oligocene at Vicksburg, Mississippi; Haldeman.

A fragment of an unmistakable *Trigonulina* was found in the marl filling

another fossil collected by Haldeman at Vicksburg. It has about twelve ribs and may prove to belong to *V. Cossmanni*, but for the present it seems best to list it separately in the hope of obtaining more perfect specimens.

Verticordia (Trigonulina) Cossmanni n. sp.

?Verticordia eocensis var. O. Meyer, Bericht Senck. Ges., 1887, p. 16.
Verticordia eocænensis Cossmann, Notes Compl., p. 7, pl. i., fig. 6, 1894.

Eocene of Jackson, Mississippi, O. Meyer; Oligocene of the Chipola beds, Calhoun County, Florida, Burns.

The species figured by my friend M. Cossmann, on the authority of Meyer, as that of Langdon is quite distinct from *V. eocenensis* and even belongs to a different section of the genus. It is, in fact, a *Trigonulina*, while *V. eocenensis* is a typical *Verticordia*. I am not quite certain that the Chipola form is specifically identical with that from Jackson so well figured by M. Cossmann, but it is certainly very closely related to it, and I prefer, for the present at least, to consider them as conspecific.

Verticordia (Trigonulina) bowdenensis n. sp.

Verticordia ornata Guppy, in coll., not of Orbigny.

Oligocene marl of Bowden, Jamaica; Vendryes and Henderson.

Shell small, rotund, rather convex, with eight or nine anterior radial ribs with deep, subequal interspaces, then a wider space followed by two adjacent ribs, then a much wider space with another adjacent pair beyond it separated by a smooth area, larger in the left than in the right valve, from the posterior margin; the surface when intact is covered with minute granules arranged in rows harmonizing with the ribs; lunule very deeply impressed in the left valve, less so in the right; tooth of the right valve large and strong, the posterior margin of the left valve modified to form a lamina or lateral tooth received in a groove of the opposite valves. Lon. 2.7, alt. 2.6, diam. 2.0 mm.

Very similar to *V. Cossmanni* but more plump and orbicular.

Verticordia (Trigonulina) Emmonsi Conrad.

Verticordia (sp.) Emmons, Geol. Rep. N. Car., p. 286, fig. 206, 1858.
Verticordia Emmonsi Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 289, 579, 1863; Meek, Checkl. Miocene Inv. Fos., p. 6, 1864.

Miocene of North Carolina, Emmons; at Wilmington, North Carolina, Stanton; Pliocene of the Caloosahatchie marl, Florida, Dall.

Shell with nine anterior and two posterior widely separated ribs, the sur-

face covered with a coarse granulation arranged in radial lines. Lon. 6.5, alt. 5.3, diam. 2.5 mm. The teeth are strong and the sinuation of the pallial line conspicuous though shallow.

This is the largest of the species of this division of the genus and with much the most conspicuous granulation. From the recent *V.* (*T.*) *ornata* Orbigny it is distinguished by its size and by the fact that the recent species has such minute granulation that it is difficult to make it out.

The recent species ranges on our eastern coast from Martha's Vineyard south to Cape San Roque, Brazil; on the Pacific coast it is known from the Gulf of California to the Santa Barbara Islands, and it was dredged in the China Seas by A. Adams. It usually has eight ribs, the two posterior ones sometimes in duplicate. It has been called *V. cælata* by Verrill and *V. novemcostata* by Adams, but I have been unable to find any constant characters by which the mutations might be separated. Notwithstanding its wide distribution, this species has not yet been recognized in the fossil state, our Pliocene form being referable to *V. Emmonsi.* The species from the Pacific coast, which is identical with Orbigny's *Trigonulina ornata,* was renamed *Hippella hippagus* by Mörch. His specimens came from Punta Arenas, Central America.

Superfamily ANATINACEA.

Family LYONSIIDÆ.

Genus **LYONSIA** Turton.

Lyonsia Turton, Dithyra Brit., p. 34, 1822. Type *Mya striata* Montagu = *M. norvegica* Gmelin.

Magdala (Leach MS.) Brown, Ill. Conch. Gt. Brit., expl. pl. xi., figs. 1, 2, 10, 1827; *Mya striata* Leach, Zool. Textb., p. 464, 1832; Conch. Textb., p. 142, 1833; Leach, Moll. Gt. Brit., p. 269, 1852.

Hiatella Brown, Ill. Conch. Gt. Brit., expl. pl. xvi., figs. 26, 27, 1827; not of Zool. Textb., i., p. 447, 1832, nor *Hiatella* Daudin, 1802 (= *Saxicava*).

Myatella Brown, Zool. Textb., i., p. 464, 1832; Ill. Conch. Gt. Brit., 2d ed., p. 111, pl. xl., figs. 26–27, 1844.

Tetragonoste Deshayes, Encyc. Méth., iii., p. 590, 1830.

Tetragonostea Herrmannsen, Ind. Gen. Malac., ii., p. 565, 1849.

Osteodesma Deshayes, An. s. Vert., vi., p. 84, 1835 (not of Deshayes, Dict. Class. d'hist. Nat., 1830); An. s. Vert. bassin de Paris, i., p. 258, 1858.

Pandorina Detken in Scacchi, Cat. Conch. reprint, 1857, p. 6; not of Scacchi, 1836, nor Bory St. Vincent, 1824.

Pandorina Möller, Ind. Moll. Grönl., p. 20, 1842.

>*Entodesma* Philippi, Arch. für Naturg., i., p. 52, 1845; *ibid.*, 1847, p. 66; Phil., type *E. chilense;* Carpenter, Suppl. Rep. Brit. Assoc. for 1863, p. 638, 1864.

>*Philippina* Dall, Moll. Porto Rico, Bull. U. S. Fish Com. for 1900, p. 498, 1901. Type *Lyonsia beana* Orbigny.

This group has had a varied synonymy as above noted. It is divisible into the following subgenera:

Subgenus *Lyonsia* s. s. Type *L. norvegica* Gmelin.

Thin, elongated, with fine radial sculpture externally; periostracum inconspicuous, usually with more or less adherent sand; moderately inequilateral. Distribution world wide, but especially the colder seas.

Subgenus *Entodesma* Philippi. Type *E. chilense* Philippi.

Large, coarse, irregular, with the nestling habit, a very coarse periostracum, hard, pearly shell, and a very large lithodesma. Distribution temperate and tropical seas.

Section *Allogramma* Dall, 1903. Type *Lyonsia formosa* Jeffreys.

Valves with radial and vertical undulations, gaping behind but not below; siphons very short, with a profusion of long, tentacular filaments and a slender, cylindrical foot.

Section *Philippina* Dall. Type *Lyonsia beana* Orb., 1845 (+ *braziliensis* Gould, 1850, + *Orbignyi* Fischer, 1857).

Shell small, thin, polished, very inequilateral, the anterior end short, attenuated, gaping below, compressed behind, often with color painting. Distribution in the warmer seas, commensal with sponges or compound Ascidians.

Owing to the delicacy and usual *situs* of the shells of this genus it is rare to find them in the fossil state. Of typical *Lyonsia* there are three species on the Atlantic coast, *L. floridana* Conr., *L. hyalina* Conr., and *L. arenosa* Möller. The latter is an Arctic species and is found in the *Leda* clays of the Pleistocene in Maine, New Brunswick, and Quebec. It is the *Osteodesma æruginosa* of Mighels. *Lyonsia* (*Allogramma*) *formosa* has been dredged in the Gulf of Campeche; *Entodesma* (*Philippina*) *beana* Orbigny extends from Cape Hatteras to the Brazilian coast, but neither is known in a fossil state.

Lyonsia acuta n. sp.

Plate 57, Figure 24.

Pliocene marl of Shell Creek, Florida; Burns.

Shell small, inequivalve, inequilateral, elongate, the beaks two-sevenths of

the whole length from the anterior end, small, pointed, recurved above a small, impressed but not circumscribed, lunular area; posterior dorsal slope straight, base gently arcuate, the posterior end pointed, with a very short terminal truncation; surface concentrically striate, finely granulose, with four faint, distant, radial threads on the posterior part of the left valve and a shallow sulcation just below the dorsal border extending from the umbo to the posterior end of the shell; hinge normal, margins entire, interior slightly pearly, the pallial sinus attaining the posterior third of the shell. Length 7, height 3, diameter 2 mm.

Two valves, one much smaller than the other, the left valve apparently adult, were obtained from the marl. While the posterior end is not absolutely pointed, it is so nearly so as to justify the name given to the species, which is much more acute than any hitherto recorded.

Family PANDORIDÆ.

Genus **PANDORA** Hwass.

<*Pandora* Hwass, in Chemnitz, Conchyl. Cab., xi., p. 211, 1795; first species *Tellina inæquivalvis* Linné.

= *Pandora* Bruguière, Encyc. Méth., livr. ii., pl. ccl., 1797; Lamarck, Prodrome, p. 88, 1799; Schumacher, Essai, pp. 39, 114, 1817; Carpenter, P. Z. S., 1864, p. 201.

Calopodium Bolten, Mus. Bolten, 1st ed., p. 166, 1798; 2d ed., p. 116, 1819. *Tellina inæquivalvis* Linné.

Pandorina Scacchi, Cat. Conchyl., p. 6, 1836; not of Detken's reprint, 1857; nor of Bory St. Vincent, 1824.

Trutina Brown, Ill. Conch. Gt. Brit., expl. pl. xiii., fig. 5, 1827; 2d ed., p. 104, pl. xlvii., figs. 5, 12, 13, 1844.

>*Kennerlia* Carpenter, P. Z. S., 1864, p. 602, type *K. filosa* Cpr., *loc. cit.;* Proc. Acad. Nat. Sci. Phila. for 1865, p. 55.

>*Clidiophora* Carpenter, P. Z. S., 1855, p. 228, type *C. claviculata* Cpr., *loc. cit.;* P. Z. S., 1864, p. 596.

>*Cœlodon* Carpenter, P. Z. S., 1864, p. 599. Type *Pandora ceylanica* Sowerby.

Not *Pandora* Megerle, 1811; = *Pecten* Muller s. s.

Pandorella Conrad, Proc. Acad. Nat. Sci. for 1862, xiv., p. 572, 1863; Am. Journ. Conch., iii., p. 269, 1867, *olim.*

The first mention of this genus is by Chemnitz, who explains that Hwass had erected *Tellina inæquivalvis* L. into a genus with some other Linnean Tellinas. In the original catalogue of Scacchi following the name of *Pandorina coruscans*, otherwise nude, is the synonym *Tellina inæquivalvis* L., which (though it is probably a typographic misplacement) is not corrected or

explained, though Detken in his reprint (stated to be absolutely unchanged from the original) places the synonym after the next preceding name in the list. In 1855 Carpenter separated *Clidiophora* and in 1864 he published a brief revision of the genus. The type originally named *Solen inæquivalvis* by Linné was transferred to *Tellina* in the twelfth edition of the "Systema Naturæ," and was subsequently named *Pandora rostrata* by Lamarck, a name which has been widely used. Because, after stating that the genus was founded on the Linnean species by Hwass, Chemnitz queries whether his own *Anomia ænigmatica* might not belong to it is not a reason for rejecting Hwass's name, as mistakenly claimed by Fischer in his "Manual," otherwise we should have to adopt *Calopodium*.

The characteristics of the anatomy have been already mentioned (p. 532), but some consideration may be given to the hinge.

The beaks of *Pandora* are erect, and in the adult always more or less eroded. The ligament and resilium lie initially beneath them. The latter is usually longer, wholly submerged, and separate from the ligament except at its starting-point. It is set in a groove, oblique or nearly vertical, and the edges of the groove are usually a little raised. On the anterior side of the ligament, when present, is to be found a long, strap-like lithodesma. In *Pandora* s. s. and *Cœlodon* there is no lithodesma developed. The normal number of teeth or laminæ in each valve would appear to be three, but they may be merged in the cardinal border or the raised edge of the chondrophore, so that in *Pandora* s. s., when adult, the left valve appears to be without teeth and the right valve has only two. The teeth are formed, as in other cases, of a shank or lamina and a hook. Usually these become separated at an early age, forming two separate teeth, but in *Cœlodon* the anterior left cardinal not only retains its connection with its "hook," but as the shell grows the entering angle between the hook and shank, by the fusing of the distal edges of the laminæ, is, as it were, partially roofed over, a feature of which the most conspicuous examples in other groups occur in the *Mactridæ*. The formulæ are as follows: *Clidiophora*, $\frac{\text{L. 10r1010}}{\text{R. 01r0101}}$; *Cœlodon*, $\frac{\text{L. 10r0Λ0}}{\text{R. 01r101}}$; *Pandora*, $\frac{\text{L. 0r01}}{\text{L. 1r10}}$. The anterior left cardinal in the latter is represented only by a callosity on the anterior dorsal border of the valve in front of the umbonal notch. In all the groups the laminæ have a tendency to pedunculation, the bases being narrower than the distal portion. They are therefore very liable to be broken off in opening the valves and are sometimes so interlocked that the animal itself can open the valves but to a trifling extent. The ligament is short and black; it usually appears to extend over the upper ends of the laminæ in a horizontal direction or it may

dip obliquely into the valves. In one case observed the ends of the ligament descended one in front and the other behind the upper end of the resilium, but the normal position is in front of the resilium. The lunule and escutcheon when present are compressed and almost linear, the dorsal margin of the flat valve usually slightly overlies that of the convex valve. The pallial line is in this genus largely a misnomer, for the mantle is attached to the shell by a succession of rounded spots which are not continuous; the visceral area of the disk may be smooth, but is often punctate or radially striate and brilliantly pearly. The left valve is the convex one, and the ventral margin of the right valve is generally more or less flexible, so that there is an entering angle above it when the shell is closed so that the solid portions of the valves come together. The pearly layer is overlaid by a conspicuous, often partly eroded, prismatic layer, and that by a periostracum which in the northern species is often rather profuse and papery. The margin is practically entire, but they often have a few radiating threads on the posterior slope of the left valve, while on the right valve, especially in *Kennerleyia*, there are usually radial, impressed, somewhat dendritic brown lines.

The species are usually found in sandy or muddy situations, and the group is represented as early as the Cretaceous in Europe.

The group may be divided as follows:

Subgenus *Pandora* s. s. Type *P. inæquivalvis* Linné.

Two cardinals in the right valve; one obscure cardinal or none in the left valve; no lithodesma; sculpture of the right valve feebly concentric.

Subgenus *Kennerleyia* Cpr. (em.). Type *K. filosa* Cpr.

Like *Pandora* s. s., but provided with a lithodesma; the right valve radially sculptured.

This was named after Dr. Kennerley, and the corrected spelling proposed by Fischer is better than that used by Carpenter.

Subgenus *Cælodon* Carpenter. Type *Pandora ceylanica* Sowerby.

Left valve with a normal posterior and an anterior Λ-shaped cardinal; right valve with three distinct subequal cardinals but no lithodesma.

Subgenus *Clidiophora* Carpenter. Type *C. claviculata* Carpenter.

Left valve with three laminæ, two in front and one behind the resilium, the anterior ending behind the anterior adductor scar, the posterior much elongated; right valve with a very long posterior lamina, an elevated pedunculate median

lamina, and a low, obscure anterior lamina parallel and close to the median; a lithodesma is present.

Subgenus *Heteroclidus* Dall (*nov.*), 1903. Type *Clidiophora punctata* Conrad.

Like *Clidiophora,* but the long left posterior lamina absent, the right posterior lamina short, and the low anterior right lamina produced; both the anterior laminæ end in front of the anterior adductor scar; lithodesma present.

Pandora and *Kennerleyia* are widely distributed, *Cælodon* is exclusively oriental, *Clidiophora* chiefly American on either coast, and *Heteroclidus* Californian.

Pandorella, Trutina, and *Calopodium* are exact synonyms of *Pandora* s. s.

Pandora (Kennerleyia) dodona n. sp.

Plate 57, Figure 25.

Uppermost Oligocene sands of Oak Grove, Santa Rosa County, Florida; Burns and Aldrich.

Shell small; left valve very convex, when adult somewhat twisted, attenuated distally, with a slender, blunt rostrum; anterior area defined by an obsolete sulcus and with the central area smooth; posterior dorsal area bounded below by a single radial thread and somewhat concentrically wrinkled, hinge-plate normal, disk with the muscular impressions strongly marked; right valve slightly concave, with a strong posterior dorsal keel, concentrically striated and with a few radial incised lines. Length 12.5 (to 15.0), height 5.2, diameter 2.0 mm.

This species is somewhat like *P. carolinensis* Bush, but more slender and more enrolled; in fact, in the latter respect our other species, recent or fossil, approach it closely only exceptionally.

Pandora (Kennerleyia) arenosa Conrad.

Myadora arenosa Conrad, Proc. Acad. Nat. Sci. Phila., iii., p. 21, 1848.

Pandora arenosa Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 130, 1834; Fos. Medial Tert., p. 2, pl. i., fig. 3, 1838.

Pandorella arenosa Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 572, 1863; Am. Journ. Conch., iii., p. 269, 1867, *olim;* Meek, Checkl. Mioc. Fos. N. Am., p. 12, 1864.

Pandora carolinensis Bush, Trans. Conn. Acad., vi., pt. ii., p. 474, 1885.

Miocene of the York River, Virginia, near Yorktown, Harris; upper Miocene of Duplin County, North Carolina, at Magnolia; Pliocene marls of Shell Creek, Florida; living off Cape Hatteras in abundance in seven to forty-eight fathoms, United States Fish Commission.

Blunter, with the patulation of the base more posterior and less enrolled than *P. dodona,* which, also, does not attain so large a size. I have not been able to find any distinctive characters between the fossils and the recent shell called *P. carolinensis* by Miss Bush. It should not be confounded with *Pandorina arenosa* Möller, which is a *Lyonsia.*

Pandora (Clidiophora) crassidens Conrad.

Pandora crassidens Conrad, Fos. Medial Tert., p. 2, pl. i., fig. 2, 1838; Proc. Acad. Nat. Sci. Phila., xiv., p. 572, 1863; Meek, Checkl. Miocene Fos. N. Am., p. 12, 1864.

Pandora crassa Conrad, Am. Journ. Conch., iii., p. 269, 1867 (*lapsus*).

Miocene of the York River, Virginia, Harris; of the Nansemond River near Suffolk, Virginia, Burns; of the Natural Well, Duplin County, North Carolina; and of the upper bed at Alum Bluff, Calhoun County, Florida.

This is the precursor of the *P. Gouldiana* Dall of Massachusetts Bay, but is a larger and coarser shell, with larger teeth on the hinge and more arcuate laterally. The development of the hinge in these Miocene Clidiophoras is less clean-cut and distinct than in the recent type. The fossils are obviously less different from *Pandora* s. s. than the recent shells are, and it is not always easy to decide in which of the two subgenera a given species should be placed, as the additional teeth are not distinct.

Pandora (Clidiophora) trilineata Say.

Pandora trilineata Say, Journ. Acad. Nat. Sci. Phila., ii., p. 261, 1822; American Conch., pl. ii., 1830; Conrad in Morton, Synops. Org. Rem., App., p. 3, 1834; Bull. Nat. Inst., ii., p. 190, 1842; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 76, pl. xx., fig. 13, 1857.

Pandora nasuta Sowerby, Sp. Conch., figs. 18, 19, 1830; Reeve, Conch. Icon., xix., *Pandora,* pl. iii., fig. 18, 1874.

"*Pandora tabacea* Meuschen" of several authors.

Not *P. trilineata* of New England writers to 1870, which is *P. Gouldiana* Dall.

Clidiaphora tabacea var., Carpenter, P. Z. S., 1864, p. 597.

Clidiaphara nasuta Carpenter, *op. cit.,* p. 597.

Pandora (*Clidiaphara*) *trilineata* Dall, Bull. Mus. Comp. Zool., xii., No. 6, p. 312, 1886; Bull. U. S. Nat. Mus. No. 37, p. 68, 1889; Proc. U. S. Nat. Mus., xxiv., p. 511, pl. xxxi., fig. 4, 1902.

Pandora (*Clidiaphora*) *floridana* (Dall MS.) *olim,* Bull. Mus. Comp. Zool., xii., p. 312, 1889.

Miocene of the Darlington district, South Carolina, Tuomey and Holmes, and of Wilmington, North Carolina, Burns; Pliocene of Mrs. Purdy's marl-

pit, Waccamaw River, South Carolina, Johnson, and of the Caloosahatchie marl, on the Caloosahatchie River, Florida, Dall. Living from Cape Hatteras, North Carolina, to the Gulf of Mexico in six to eighteen fathoms, sand or mud.

This species was long lost sight of, or confounded with the broad, flat New England species which I have named *P. Gouldiana.* Like the other American species referred to *Clidiophora,* except *P. claviculata,* it is not quite typical. The last-mentioned species has long and conspicuous posterior hinge-teeth, while in the others this feature is replaced by relatively quite short and inconspicuous teeth, as in the present case. As the tooth is present, though short, it is perhaps hardly worth while to separate the group from *Clidiophora.*

Pandora (Kennerleyia) lata n. sp.

Plate 57, Figure 18.

Miocene of Maryland (St. Mary's County?) collection of the National Institute.

Shell small, left valve very convex, patulous below behind, with a rather broad escutcheon bounded by a strong carina; anterior area short, posterior area very narrow; rostrum very short and blunt, slightly recurved; surface concentrically striated; hinge-teeth short and small; lunule very deep, compressed, so as to appear linear; right valve slightly concave, concentrically striated, with traces of the usual impressed radiating lines. Length 19.0, height 10.5, diameter 3.5 mm.

This species is shorter and thicker than *P. arenosa* and much less acute. Its exact provenance is not known, as it was received from the old National Institute, but the specimens have the livid purple color characteristic of many of the St. Mary's fossils, and it is possible it was collected in that region.

Pandora (Kennerleyia) arctica n. sp.

Plate 57, Figure 26.

Leda clays of the St. Lawrence drainage (Dawson) and Pleistocene, probably equivalent clays on the coast of Maine, at Saco (Packard), and of New Brunswick (Matthews).

Shell small, oval, nearly flat, with no perceptible rostrum; anterior area and posterior dorsal area rather large, the latter hardly differentiated from the middle area of the disk; sculpture of concentric, somewhat rude, striation, lunule and escutcheon nearly linear; there are no radial threads near the dorsal margin; the right valve is flat, with some irregularly radial striæ and the usual concentric striation. Length 16.5, height 9.0, diameter 2.5 mm.

This was long confounded with *K. glacialis,* by which name Dawson cites it and points out its peculiarities, how its hinge differs from *P. Gouldiana* and its nearest ally seems to be the *P. pinna* or *obtusa* of Europe. It is a much smaller and relatively heavier species than the recent *P. glacialis* Leach, of which, perhaps, it is the glacial precursor in the clays.

Pandora (Clidiophora) Gouldiana Dall.

Pandora trilineata Conrad, Am. Marine Conch., p. 49, pl. x., figs. 1, 2, 1831; Greene, Mass. Cat., 1833; Gould, Inv. Mass., p. 44, 1841; Russell, Tr. Essex Inst., i., p. 54, 1839; Mighels, Bost. Journ. Nat. Hist., iv., p. 314, 1843; De Kay, Nat. Hist. N. Y., v., p. 237, pl. xxxiii., fig. 310, 1843; Stimpson, Shells of N. Engl., p. 23, 1851; Tryon, Am. Mar. Conch., p. 136, pl. xviii., figs. 305–7, 1874; Binney's Gould's Inv. Mass., p. 62, fig. 379, 1870; not of Say, 1822.

Pandora Gouldiana Dall, Bull. Mus. Comp. Zool., xii., p. 312, 1886; Bull. U. S. Nat. Mus. No. 37, p. 68, pl. lix., fig. 14, 1889.

Pandora (Clidiophora) Gouldiana Dall, Proc. U. S. Nat. Mus., xxiv., p. 511, pl. xxxii., fig. 7, 1902.

Pleistocene of Maine, Mighels; and of Massachusetts, Stimpson; living from Nova Scotia to Virginia in six to thirty fathoms.

This species has been by all the New England writers, following Gould, confused with the more delicate and slender species from the south named by Say and figured in his "American Conchology." With the latter *P. nasuta* Sowerby has been united, but perhaps without sufficient warrant; with the former an oriental species, *P. depressa* of Sowerby, also a doubtful proceeding. The *P. tabacea* Meuschen is hardly determinable and may well be ignored.

Pandora (Heteroclidus) punctata Conrad.

Pandora punctata Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 228, pl. xvii., fig. 1, 1837; Gabb, Pal. Cal., ii., pp. 54, 90, pl. xv., fig. 12, 1869.

Miocene of California (var. *Gabbi* Dall) near San Buenaventura, Gabb; living on the coast of California from Baulinas Bay to San Diego in moderate depths of water.

For the Miocene form, which wants the characteristic punctations of the recent shell, I propose the varietal name of *Gabbi.*

Another form referred to *Pandora* s. s. by Gabb, and named by him *P. scapha,* is reported from the Miocene of California. From the Pliocene or Pleistocene beds of Santa Barbara Conrad described in 1855 a *Pandora bilirata.* The same species was named from the recent fauna by Carpenter in 1864 *P.*

bicarinata. It is a *Kennerleyia*. From the Tertiary of St. Domingo Gabb described in 1873 a *Pandora inconspicua*, but its exact horizon is unknown and it still remains unfigured.

Family THRACIIDÆ.

Genus **THRACIA** Blainville.

Rupicola Fleurian, Journ. de Physique, liv., p. 345, 1802. Type *Rupicola concentrica* Fleurian, *loc. cit.* = *Mya distorta* Montagu; not *Rupicola* Brisson, *Aves*, 1760.

Thracia (Leach MS.) Blainville, Dict. Sci. Nat., xxxii., p. 347, 1824; Man. Mal., i., p. 564, 1825; ii., p. 660, 1827; Raug, Man., p. 324, 1829; Philippi, Moll. Sicil., i., p. 18, 1836; ii., p. 16, 1844; Gray, Ann. Mag. N. Hist., xx., p. 272, 1847; Couthouy, Bost. Journ. N. Hist., ii., p. 129, 1839; Leach, Moll. Gt. Brit., p. 270, 1852.

Thracia A, Blainville, *op. cit.*, p. 347, 1824, and p. 565, 1825. Type *T. carbuloidea* Blainville, pl. lxxvi., fig. 7. This group of 1825 is selected as typical by Blainville, Man. Mal., ii., p. 660, 1827.

Thracia B, Blainville, *op. cit.*, p. 347, 1824, and p. 565, 1825. Type *Mya pubescens* Linné. This shell was not seen by Blainville, who expunges the section founded on it in his vol. ii., p. 660, 1827.

Anatina A, Blainville, *op. cit.*, i., p. 564, 1825. Type *Anatina myalis* Lam. (= *Thracia pubescens* Pult. sp.). Group transferred to *Osteodesma*, vol. ii., p. 659, 1827.

Anatina C, Blainville, *op. cit.*, p. 564, 1825. Type *Anatina rupicola* Lam. Transferred to *Osteodesma* B, vol. ii., p. 660, 1827.

Osteodesma (Deshayes MS.) Blainville, Man. Mal., ii., p. 659, 1827. Type *Anatina myalis* Lamarck.

Not *Osteodesma* A, Blainville, *op. cit.*, p. 660, 1827. Example *O. trapezoidalis* (*sic*) Lam., figured pl. lxxvi., figs. 8, 8a, which is a *Periploma trapezoides* Lam.

>*Ostcodesma* B, Blainville, *loc. cit.* (= *Rupicola* Fleuriau), p. 660; *Anatina rupicola* Lamarck, = *Rupicola concentrica* Fleuriau + *Thracia distorta* Montagu (sp.).

Hemicyclanosta Blainville, Man. Mal., ii., p. 660, 1827; not of Deshayes, An. s. Vert., vi., p. 450, 1835.

Thracia Deshayes, Dict. class. d'hist. Nat., xvi., p. 235, 1830; *Thracia pubescens* Lam.

Odoncinetus O. G. Costa, Cat. Sist., pp. 14, 23, 1829; *Thracia phascolina* Lamarck, *fide* Philippi.

Odontocincta Philippi, Handb. Conch., 1853. Err. typ. pro *Odoncinetus* Costa, *fide* Philippi.

Odancincta, Odontocincta, Odoncyneta, in Gray, P. Z. S., 1847, p. 191. Erroneous forms of *Odoncinetus* Costa.

Cinetodanta Herrmannsen, Ind. Gen. Mal., p. 138, 1847, = *Odoncinetus* Costa, corrig.

Odoncineta Agassiz, Nom. Index., p. 736, 1848; = *Odoncinetus* Costa.

Odontocineta Agassiz, Nom. Index, p. 736, 1848, = *Odancinetus* corrig.

Ixartia Leach, Moll. Gt. Brit., p. 272, 1852. *Thracia distorta* Montagu (sp.); Fischer, Man. de Conchyl., p. 1171, 1887; Bucquoy, Dautzenberg et Dollfus, Moll. Mar. de Roussillon, ii., p. 740, 1898.

Corymya Agassiz, in Sowerby, Min. Conch., ed. Germ., pp. 439, 651, 1843. Type *Mya depressa* Sby.

Corimya Agassiz, *op. cit.*, p. 577, 1843.

Cyathodonta Conrad, Proc. Acad. Nat. Sci. Phila., iv., p. 155, 1849; Fischer, Man. de Conchyl., p. 1171, 1887. Type *C. undulata* Conrad. Lower Cal.

Rupicilla Schaufuss, in Pætel's Cat., p. 18, 1867; new name for *Rupicola* Fleuriau *non* Brisson.

Homœodesma Fischer, Man. de Conchyl., p. 1171, 1887. Type *Thracia Conrodi* Couthouy.

Pelopia H. Adams, P. Z. S., 1868, p. 16; *P. brevifrons* Ads., pl. iv., fig. 16.

Ligula (sp.) Montagu, 1808; Brown, 1827.

This group for an assemblage of such simple characters has had a very complex synonymy. The differences between the various members of it are so slight as to have apparently no more than sectional value. They are as follows:

Section *Thracia* s. s. Type *T. corbuloidea* Blainville.

Shell concentrically striated, with more or less fine superficial granulation and a very delicate periostracum; subrostrate, slightly gaping behind; slightly inequivalve, the right valve larger; the beaks in contact and usually perforated by friction on each other, the hinge-plate fissured below them and edentulous; the ligament external, the resilium more or less sunken and with, in most cases, a short, transverse lithodesma in front of it, occupying the fissure in the hinge-plate; pallial line with a moderate sinus, margins of the valves entire; the nymphs in the typical forms do not project greatly from the hinge-margin ventrally and are more or less elongated; the shell is destitute of nacre.

In this group the lithodesma or ossicle is quite small and frequently lost. The valves cannot be opened after death without snapping it, and it is usually deficient in cabinet specimens. For *T. Conradi* Fischer made a section, as it was supposed to be without a lithodesma, but I have found it present in the young, though so small that it has been generally unrecognized. The siphons are entirely separated and have a very few terminal papillæ.

Section *Ixartia* Leach. Type *T. distorta* Montagu.

Valves irregular from the nestling habit; the resiliifer short, prominent, projecting into the cavity of the shell, a lithodesma present.

Pelopia H. Adams, *Rupicola* Fleuriau, not Brisson, and *Rupicilla* Schaufuss are supposed to be synonymous.

Subgenus *Cyathodonta* Conrad. Type *T. undulata* Conrad.

Shell resembling *Thracia* but with a sculpture of strong oblique ripples; hinge-plate not fissured, but continuous; beaks entire; the resiliifers short, rounded, prominent, with a thin, semicircular, vertically pendant lithodesma in front of them.

The genus recedes in time to the Trias, and for the Mesozoic species Agassiz proposed the genus *Corymya,* which, however, is regarded by Zittel as not distinct from *Thracia.* The Tertiary species are not abundant and, owing to the delicate structure of the shell, are rarely well preserved. *Cyathodonta* is well developed in the Oligocene, species appearing in the Vicksburgian and Antillean beds as well as in those near Bordeaux, France. It is represented by a few species in the existing fauna, which in accordance with its geological antiquity are widely distributed in Africa, the Indo-Pacific, California, and the Caribbean waters.

Thracia Dilleri Dall.

PLATE 34, FIGURE 19.

Thracia Dilleri Dall, Trans. Wagner Inst., iii., p. 929, pl. xxxiv., fig. 19, 1898.

Middle Eocene of the Arago beds, near Cape Arago, Coos County, Oregon; J. S. Diller, United States Geological Survey.

Shell of moderate size, thin, elongated, inequilateral, nearly equivalve, moderately convex; anterior side shorter, surface concentrically feebly undulated, slightly granulose as usual in the genus; basal margin somewhat flexuous, an obscure ridge running to the middle of the base and another to the basal posterior angle in the left valve, a marked carina extending from the beaks near and almost parallel to the dorsal margin, the space between the margin and the carina wider in the right valve; posterior end subtruncate, produced, beaks adjacent, inconspicuous. Alt. 30, lon. 48, diam. 16 mm.

This species is sufficiently distinguished by its elongated form from any of the other species of the genus in the Pacific coast Tertiaries.

Thracia Conradi Couthouy.

Thracia Conradi Couthouy, Boston Journ. Nat. Hist., ii., p. 183, pl. iv., fig. 2, 1838; Am. Journ. Conch., iv., App., p. 54, 1868; Dall, Bull. U. S. Nat. Mus. No. 37, p. 64, pl. lxix., fig. 9, 1889.

Anatina convexa Greene, Mass. Cat., 1833; not of Turton.

Thracia declivis Conrad, Am. Marine Conch., p. 44, pl. ix., fig. 2, 1831; not of Pennant, 1778.

Thracia declivis Reeve, Conch. Icon., *Thracia*, sp. 4, 1859; not of Pennant.

Miocene of Maryland, on left bank of Patuxent River a quarter of a mile south of Burch, Harris; of the upper bed at Alum Bluff, Calhoun County, Florida, Burns; living from Labrador to Cape Hatteras in three to fifteen fathoms, sand or mud.

The fossils are in poor condition but resemble *T. Conradi* except in the higher anterior dorsal arch, and in being thicker and heavier than any recent specimens I have seen. One cannot without better material be certain of the identity of the recent and fossil specimens, for which reason I prefer to regard the latter as forming a variety *Harrisi* pending the receipt of further information.

Thracia transversa H. C. Lea.

Thracia transversa H. C. Lea, Trans. Am. Phil. Soc., N. S., ix., p. 237, pl. xxxiv., fig. 11, 1845; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 572, 1863; Meek, Checkl. Mioc. Fos. N. Am., p. 11, 1864.

Miocene of Petersburg, Virginia, Lea and Burns; and of the York River, near Yorktown, Virginia, Harris.

Only a few specimens of this small species have been found and the material is insufficient for a critical comparison, but they appear suspiciously like the young of *T. truncata* Mighels and Adams, 1842; not *T. truncata* Turton (as *Anatina*), 1822; = *T. septentrionalis* Jeffreys, Ann. Mag. N. Hist., Oct., 1872, p. 238.

Lea's figures were very poor, but the present is the only species found at Petersburg and the identification is subject to little doubt.

Other East American species of this group are *T. myopsis* Möller, 1842 (+ *T. Couthouyi* Stimpson, 1851); *T. rugosa* Orbigny (as of Conrad MS.), 1846, which is extremely close to *T. distorta* Montagu, 1808, and *T. similis* Couthouy (+ *T. Rushii* Pilsbry), 1842. None of these has been authentically reported in the fossil state as far as I have been able to learn. On the Pacific side are *T. trapezoides* Conrad, 1849, from the Oligocene(?) of Astoria, Oregon; *T. mactropsis* Conrad, 1856, from the Miocene of California, not since recognized; and *T. ventricosa* Conrad, a nude checklist name of 1864, referred to the Miocene of Oregon. *Thracia myæformis* Conrad, from the Miocene marl of Shiloh, Cumberland County, New Jersey, is positively identified with *Saxicava* by Professor Whitfield in his study of the Miocene Mollusca of New

Jersey. *T. curta* Conrad, a recent form from California, has not yet been recorded as a fossil.

Subgenus CYATHODONTA Conrad.

Cyathodonta semirugosa Reeve.

Thracia plicata Reeve, Conch. Icon., xii., *Thracia,* pl. ii., fig. 7*a* (only), 1859; Hanley, Descr. Cat. Rec. Sh., p. 21, pl. x., fig. 37, 1843; Reeve, Conch. Syst., i., pl. xxxv., fig. 2, 1843.

Not *Thracia plicata* Deshayes, Encycl. Méth., iii., p. 1039, 1832, and Kiener, Icon. Coq. Viv., fasc. cix., *Thracia,* pl. ii., fig. 3, 1836. Senegal.

Thracia semirugosa Reeve, Conch. Icon., xii., notes to pl. ii., fig. 7, 1859. West Indies.

Thracia dissimilis Guppy, Ann. Mag. N. Hist., 4th Ser., xv., p. 52, 1874. Trinidad.

?Thracia magnifica Jonas, P. Z. S., 1849, p. 170, pl. vi., fig. 7; Reeve, Conch. Icon., xii., *Thracia,* pl. ii., fig. 11, 1859. Honduras.

Pliocene marl of the Caloosahatchie River, Florida, Dall; living in the Caribbean Sea near Santa Cruz in thirty-eight fathoms, near Trinidad Island, and on the coast of Honduras.

By following Hanley and Reeve the name *plicata* Deshayes has been generally used for the Caribbean *Cyathodonta,* but an examination of Deshayes' species as figured by Kiener from the types shows that it is entirely distinct from the American form, and Deshayes in his edition of Lamarck states that it probably came from Senegal. On the other hand, Hanley, in 1843, identified with Deshayes' species a *Cyathodonta* from New Holland, perhaps that afterwards named *Thracia granulosa* by Adams and Reeve. I have some suspicion that *T. magnifica* Jonas is only a very finely developed specimen of the *semirugosa,* in which case the latter name must give way, but in view of the differing proportions it seems best to wait for more information before uniting them. Reeve and Cuming united the Caribbean species with Conrad's Lower Californian *undulata,* which is distinct. Reeve's figures, 7b and 7c, were possibly drawn from Californian specimens.

Cyathodonta vicksburgiana n. sp.

Plate 57, Figure 27.

Vicksburgian Oligocene, at Vicksburg, Mississippi.

Shell elongate, the right valve convex, the anterior end longer, slightly attenuated, and evenly rounded; posterior end shorter, rather abruptly vertically truncated, compressed above with a rounded ridge extending from the beak to the lower posterior angle; beaks low, somewhat recurved, situated at

about the posterior third; surface with numerous nearly concentric, subequal ripples, fading out behind the vertical of the beaks and each about one millimetre wide. Length 33.5, height 19.0, diameter of right valve about 6.0 mm.

A single well-preserved internal cast in a fine-grained limestone is in the collection labelled as from Vicksburg, Mississippi, on the authority of J. B. Marcou. It is more nearly like the average typical *Thracia* in form than are the more recent *Cyathodonta.*

Cyathodonta guadalupensis n. sp.

Plate 53, Figure 6.

Oligocene of Guadeloupe Island, Lesser Antilles; J. W. Spencer.

Valves moderately convex, the left valve less so, the beaks high, nearly median, the anterior dorsal slope rapidly descending, rounded near the base; base arcuate, posterior end roundly subtruncate; sculpture of prominent, nearly concentric ripples subequally distributed except on the posterior dorsal slope, where they are obsolete, an obscure radial sulcus near the posterior dorsal margin. Length 38, height 30, the beak about 20 mm. from the posterior end; diameter of the right valve 10, of the left valve 6 mm.

A single well-preserved internal cast was obtained. The following species is very similar, but the proportions and sculpture differing in a marked way it was thought best to treat it as distinct.

Cyathodonta Spenceri n. sp.

Plate 53, Figure 8.

Oligocene limestones of Guadeloupe Island, Lesser Antilles; J. W. Spencer.

Valves moderately convex, the right valve more so, the beaks low, at three-sevenths the whole length from the posterior end; anterior slope slowly descending, terminally rounded; base arcuate; posterior slope convex, compressed, the posterior end vertically subtruncate; a rounded radial ridge between two wide, shallow depressions extending from the beaks to the lower posterior angle in the right valve; sculpture of prominent ripples, with wider interspaces, obsolete on the posterior dorsal slope. Length 43, height 32, diameter of right valve 8, of left valve 7 mm.

A single well-preserved internal cast was obtained. The sculpture is more prominent and sparse, the anterior end proportionately longer, the beaks less elevated, the posterior dorsal slope more compressed, and the valves more nearly equally convex than in *T. guadalupensis.*

De Gregorio figures a *Thracia estiva,* of which the provenance is uncertain,

in his monograph of the Claiborne fauna. It is an internal cast and has not much the aspect of a *Thracia*. It has, however, concentric ripples, and may represent a tendency towards *Cyathodonta* on the part of some Eocene form.

Family PERIPLOMATIDÆ.

Genus **PERIPLOMA** Schumacher.

Corbula (sp.) Bruguière, Encycl. Méth., livr. ii., pl. ccxxx., figs. 6a–6b, 1797.

Periploma Schumacher, Essai, p. 115, 1817, type *P. inæquivalvis* Schum., = *Anatina trapezoides* Lam.; Rang, Man., p. 325, 1829.

Osteodesma A, Blainville, Man. de Mal., ii., p. 660, 1827; *A. trapezoides* Lam.

Subgenus **COCHLODESMA** Couthouy.

Ligula (sp.) Montagu, Test. Brit. Suppl., p. 96, 1808 (*Mya prætenuis* Pult.); Brown, Ill. Conch. Gt. Brit., expl. pl. xiv., figs. 1, 2, 1827; Zool. Textb. i., p. 461, 1832; Ill. Conch. Gt. Brit., ed. ii., p. 106, 1844; not *Ligula* Bloch, *Vermes*, 1781.

Cochlodesma Couthouy, Boston Journ. Nat. Hist., ii., p. 170, 1839, type *Anatina Leana* Conrad; Gray, Ann. Mag. N. Hist., ii., p. 25, 1840.

Bontæa (Leach MS.) Brown, Ill. Conch. Gt. Brit., 2d ed., p. 106, 1844; in synonymy of *Ligula prætenuis* Brown; Gray, List. British An., Moll., p. 70, 1851.

Bontia Gray, P. Z. S., 1847, p. 190; Herrmannsen, Ind. Gen. Mal., Suppl., p. 17, 1852.

Galaxura Leach, Moll. Gt. Brit., p. 271, 1852; *Mya prætenuis* Pult.

?Calcaræa Récluz, Act. Soc. Lin. de Bordeaux, xxvii., p. 47, 1869; not *Calcarius* Bechst., 1802.

Osteodesma (Deshayes MS.) Blainville, included several incongruous forms, but Blainville mentions as the type *Anatina myalis* Lam., which is a typical *Thracia*, and therefore the name cannot be conserved.

The genus and its subdivisions show a gradual modification of the hinge-characters. In *Periploma* there is a strong, prominent clavicular rib supporting the chondrophore, and in front of the latter is a small, lunate lithodesma; in *Cochlodesma* the clavicle is obsolescent and in front of the chondrophores there is a cartilaginous mass of dark-brown color, uniting the valves and occupying the place of the lithodesma, but uncalcified. In the European form, *Bontæa*, the clavicle is non-existent, but a minute lithodesma still remains.

Periploma Collardi Harris.

Periploma Collardi Harris, Proc. Acad. Nat. Sci. Phila. for 1895, p. 52, pl. iii., fig. 4.

?Anatina claibornensis Lea, Contr. Geol., p. 40, pl. i., fig. 8, 1833.

?Periploma claibornensis Conrad, Am. Journ. Conch., i., p. 3, 1865; Checkl. Eocene Fos. N. Am., p. 34, 1866.

Lower horizon at Claiborne Bluff, Claiborne, Alabama, and in various lower Claibornian localities in Texas; Harris.

This species is abundant though crushed in the clays at the bottom of Claiborne Bluff, and the probabilities seem in favor of its being the same as Lea's species described from a fragment carrying the chondrophore from this locality. Another species described from similarly inadequate material is *P. complicata* Meyer from the Jacksonian. *P. Butleriana* Aldrich, of the Wood's Bluff horizon in Mississippi, is not very far removed from *P. Collardi.* Mr. Aldrich has received a chondrophore of late Oligocene age from the sands of Oak Grove, Santa Rosa County, Florida. It is not suitable for naming, but the presence of the genus in that horizon is worth noting.

Periploma peralta Conrad.

Periploma alta Conrad, Proc. Acad. Nat. Sci. Phila., xiv., pp. 572, 585, 1863; Am. Journ. Conch., ii., p. 70, pl. iv., fig. 10, 1866; Meek, Checkl. Miocene Fos. N. Am., p. 11, 1864; Whitfield, Mioc. Moll. N. J., p. 85, pl. xvi., figs. 7, 8, 1895; not *P. alta* C. B. Adams, as *Anatina,* 1852.

Periploma peralta Conrad, Am. Journ. Conch., iii., p. 188, 1867; new name for *P. alta,* preoccupied.

Older Miocene of Shiloh, Cumberland County, New Jersey, and Cove Point, Maryland.

This large orbicular species recalls some of the recent forms now living on the Panama coast and in California. It is rarely well preserved. I am at a loss to understand why Professor Whitfield in this connection refers to *Raëta alta* Conrad, a member of the *Mactridæ* from the Tertiary of North Carolina, since the two shells are not in the least alike.

Periploma angulifera Philippi.

PLATE 57, FIGURE 15.

Periploma angulifera Philippi, Zeitschrift für Malak. for 1847, p. 73; Dall, Bull. U. S. Nat. Mus. No. 37, p. 64, 1889.

Pliocene marl of Shell Creek, near Charlotte Harbor, Florida, Willcox; living from St. Simon's Island, Georgia, south and west to the Gulf of Mexico, the Florida Keys, Texas, and the coast of Honduras.

This well-known species is marked by the very short posterior end with a sharp keel ending in a projecting angle on the lower posterior border of the right valve. As no good figure of it is easily available, one is supplied here.

The fine *Periploma argentaria* Conrad, 1837, is not infrequent in the Pleistocene marl of San Diego, California.

Periploma (Cochlodesma) antiqua Conrad.

Anatina antiqua Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 130, 1834; Morton, Syn. Org. Rem., App., p. 3, 1834.

Periploma antiqua Conrad, Fos. Medial Tert., p. 16, pl. viii., fig. 3, 1838; Proc. Acad. Nat. Sci. Phila., xiv., p. 572, 1863; Meek, Checkl. Miocene Fos. N. Am., p. 11, 1864.

Cochlodesma antiquata Verrill, Inv. An. Vineyard Sd., p. 673, 1873.

Miocene of the York River, Virginia, near Yorktown; Conrad.

Our investigations have not resulted in the rediscovery of this species, which recalls on a larger scale the typical *Cochlodesma Leanum* (Conrad) Couthouy of the recent fauna. The latter has not yet been reported in the fossil state.

Family ANATINIDÆ.

Genus **LATERNULA** Bolten.

<*Laternula* Bolten, Mus. Boltenianum, 1st ed., p. 154, 1798; *Solen anatinus* Linné; 2d ed., p. 109, 1819; Gray, P. Z. S., 1847, p. 190, No. 626.

<*Anatina* Lamarck, Phil. Zool., p. 319, 1809; An. s. Vert., v., p. 462, 1818; Rang, Man., p. 326, 1829; not *Anatina* Schumacher, 1817, nor *Anatina* A and C, Blainville, Man. Malac., i., p. 564, 1825.

Anatina B, Blainville, Dict. Sci. Nat., xxvii., p. 347, 1824; *A. subrostrata,* Man. Malac., ii., p. 660, 1827.

Auriscalpium Megerle von Mühlfeld, Entw. eine Neuen Syst., p. 46, 1811; *Solen anatinus* Linné.

Auriscalpium α Schumacher, Essai, p. 115, 1817.

Butor Gistel, Naturg. Thierr., p. 172, 1848; = *Anatina* Lam.

The genus *Laternula* Bolten contained two species, *Mya truncata* and *Solen anatinus* of Linné. Since the former is a member of the prior genus *Mya* Linné, as restricted by Retzius, 1788, and Spengler, 1793, only one remains to carry the name and typify it. *Anatina* Lamarck was founded on the same type ten years later, though a mass of heterogeneous species were assembled under it by Lamarck himself and subsequent writers, and it was a quarter of a century before the confusion was rectified.

The genus *Laternula,* or *Anatina,* is Oriental in its recent distribution, and is not known from the North American Tertiaries. Several species belonging to other groups, as now understood, were originally described as *Anatina,* and are occasionally cited in later literature under this name. Thus *Anatina clai-*

bornensis Lea, *A. antiqua* Conrad, and *A. Butleriana* Aldrich belong to *Periploma* or *Cochlodesma*. *Anatina applicata* Conrad, a Mesozoic species, was afterwards referred to *Periploma, Leptomya* and finally to a new genus, *Periplomya* (Am. Journ. Conch., vi., p. 76, 1870). *Anatina tellinoides* Lea, from the Petersburg, Virginia, Miocene, is *Cumingia tellinoides* Conrad. None of the species of *Anatina* described by Gabb from the Chico of California seems to belong to the restricted genus *Laternula*.

Family PHOLADOMYACIDÆ.

Genus **PHOLADOMYA** Sowerby.

Pholadomya Sowerby, Genera of Shells, fasc. xix., 1823, type *P. candida* Sby., *loc. cit.*, four views; Owen, App. to Reeve's Conch. Syst., pp. 3–8, 1842; P. Z. S., 1842, p. 150; Agassiz, Etude critique Moules Fos., p. 37, 1842; Meek, Paleont. Upper Missouri, p. 213, 1876.

Pholodomyæa Fleming, Hist. Brit. An., pp. 408, 428, 1828.

Procardia Meek, Proc. Acad. Nat. Sci. Phila., xiv., p. 184, 1871 (subgenus); Paleont. Upper Missouri, p. 215, 1876. Type *Pholadomya Hodgii* Meek.

This well-known genus seems, according to Meek, to have originated during the period of the Lias. Its culmination took place during the Mesozoic, and it is represented only by a few species in the Tertiary and recent seas.

Pholadomya marylandica Conrad.

Pholadomya marylandica Conrad, Bull. Nat. Inst., ii., pp. 172, 193, pl. i., fig. 3, 1842; Am. Journ. Sci., 2d Ser., i., p. 214, pl. i., fig. 9, 1846; H. C. Lea, Proc. Acad. Nat. Sci. Phila., iv., p. 104, 1848; Conrad, Am. Journ. Conch., i., p. 3, 1865; Clark, Bull. U. S. Geol. Survey, No. 141, p. 75, pl. xix., fig. 2, 1896.

Eocene of Maryland, at Fort Washington, Piscataqua, and Marlborough, and of Virginia at Aquia Creek; Burns.

This species differs from the genus in general (if the identification by Professor Clark and Professor G. D. Harris be correct) by having the shell less nacreous and less arcuate, with only faint traces of radial sculpture and the posterior end of the shell entirely free from anything like a gape.

Pholadomya claibornensis Meyer and Aldrich.

Pholadomya claibornensis Meyer and Aldrich, Bull. Ala. Geol. Survey, i., p. 38, pl. iv., fig. 5, 1886.

Lisbon and Claiborne Eocene of Alabama; Eocene of Wilmington, North Carolina, Burns; and of Saline Bayou, Louisiana, Vaughan.

This is a small and typical species, very abundant at the last-mentioned locality, but more or less distorted or defective, owing to the delicacy of the shell.

Other species described under this name belong elsewhere. *P. Mauryi* Harris is a *Phenacomya* (see p. 823); *P. abrupta* belongs in *Margaritaria;* the Californian species appear to belong to the Cretaceous. There are two species described from the recent American fauna, *P. candida* Sowerby, the type of the genus, from the West Indian Island of Tortola, and *P. arata* Verrill, which in my opinion does not belong in this genus and may form a new one, as follows:

Genus **APOREMA** Dall.

Type *Pholadomya arata* Verrill, Am. Journ. Sci., xxii., p. 301, Oct., 1881; Trans. Conn. Acad., v., p. 567, pl. lviii., fig. 37; vi., p. 278, pl. xxx., figs. 4–6, 1884.

Off Martha's Vineyard, Massachusetts, in seventy-one to one hundred and thirty-four fathoms.

Shell trigonal, cuneate, nacreous, with radiating sculpture, a large lunular and narrow dorsal area, the surface granular under a delicate periostracum; hinge consisting of an external strong ligament seated on strong nymphs, the hinge-plate edentulous, interrupted under the beaks by an indentation; pallial line not sinuated.

The lamina on the type specimen referred to by Professor Verrill has the appearance of being pathological, and in the hinge of the left valve of another specimen there is no corresponding socket. The pallial line is obscure, but seems to be certainly not sinuated. There is no indication of any lithodesma.

This group will include *Pholadomya africana* Fischer and *P. Locardi* Dall (*P. arata* Locard, Talisman, Rep. ii., 165, pl. viii., figs. 1–5, 1898, not of Verrill, 1881) from deep water off the coast of west Africa, and perhaps the *P. Loveni* Jeffreys, which, however, has the hinge-plate not interrupted and sculpture more like the true *Pholadomya.* It is separated from *Pholadomya* by the hinge-characters, form, and absence of a pallial sinus, from the Lyonsias by the wholly external ligament, absence of a lithodesma and of a pallial sinus.

Genus **MARGARITARIA** Conrad.

Margaritaria abrupta Conrad.

Pholadomya abrupta Conrad, Fossil Shells of the Tertiary Form. of N. Am., p. 26, pl. xii., figs. 1, 2, 1832; Foss. Medial Tert., p. 3, pl. i., fig. 4, 1838; Proc. Acad. Nat. Sci.

Phila., i., p. 329, 1843; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 101, pl. xxii., fig. 2, 1856; Emmons, Geol. Rep. N. Car., p. 300, fig. 231, 1858.

Panopæa abrupta Sowerby, Min. Conch., vii., p. 4, 1829; Deshayes, An. s. Vert., vi., p. 66, 1835; Valenciennes, Arch. du Mus. d'hist. Nat., i., p. 36, 1840.

Pholadomya (Margaritaria) abrupta Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 572, 1863.

Margaritaria abrupta Meek, Checkl. Miocene Fos. N. Am., p. 12, 1864.

Miocene of Virginia at Petersburg, Yorktown, Suffolk, and Grove Wharf on the James River; of Edgecombe County and the Natural Well, Duplin County, North Carolina; of Sumter, Smith's, Darlington, and Goose Creek, South Carolina.

Shell nacreous, subsolenoid in form, sparsely radially sculptured; rounded and slightly gaping in front, abruptly truncate and widely gaping behind; the beaks submedial, low, ligament external, elongate, on strong nymphs; hinge-plate continuous, edentulous, narrow; muscular impressions distinct; pallial line wide, somewhat irregular, sometimes apparently entire, sometimes with a short angular sinus, at the posterior lower angle of which there is a rather large, strong scar, as if the mantle had had here a specialized area of attachment to the shell. This last arrangement occurs in one specimen only, and it is possibly pathological; at any rate, the specimens with an entire pallial line seem more normal. The surface when unworn is more or less granular and resembles that of *Thracia;* the interior is brilliantly pearly. The characters of this curious shell have never been fully described, and I have thought it well to call attention to them here. Its relations are certainly most puzzling. I was strongly tempted to place it near *Lyonsia,* but the arrangement of the ligament is more like that of *Thracia* and there is nothing to suggest the presence of a lithodesma. Its sculpture and nacre are opposed to affiliation with *Panopea* even if we disregard the pallial sinus, but there is something in the aspect of it which recalls *Allogramma.*

Class BRACHIOPODA.

The non-molluscan classes having been placed in the hands of other students for examination,—Dr. W. B. Clark having undertaken the Echinoderms, Mr. T. W. Vaughan the corals, and Dr. Bagg having the Foraminifera under consideration,—the results of their work will appear separately. It was thought best, however, in view of the small number of species, to give a list of the brachiopoda which are met with in the Tertiary strata of our southeastern coastal plain.

Family DISCINIDÆ.

Genus **DISCINISCA** Dall.

Discinisca lugubris Conrad.

Plate 58, Figure 13.

Capulus lugubris Conrad, Journ. Acad. Nat. Sci. Phila., vii., p. 143, 1834.

Orbicula lugubris Conrad, Fos. Medial Tert., p. 75, pl. xliii., fig. 2, 1845; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 17, pl. v., fig. 1, 1855.

Discina lugubris Meek, Miocene Checkl., p. 3, 1864; Whitfield, Miocene Moll. N. J., p. 23, pl. i., figs. 1–3, 1895.

Discinisca lugubris Dall, in Bull. U. S. Geol. Survey No. 87, p. 219, 1897.

Orbicula lugubris Emmons, Geol. Rep. N. Car., p. 274, fig. 187, 1858; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 582, 1863.

Orbicula multilincata Conrad, Fos. Medial Tert., p. 75, pl. xliii., fig. 3, 1845; Tuomey and Holmes, Pleioc. Fos. S. Car., p. 18, pl. v., fig. 2, 1855; Conrad, Proc. Acad. Nat. Sci. Phila., xiv., p. 582, 1863.

Discinisca multilineata Dall, Bull. U. S. Geol. Survey No. 87, p. 219, 1897.

Older Miocene of Shiloh, Cumberland County, New Jersey, Burns; Miocene of Atlantic City, New Jersey, in artesian borings; of Maryland, in St. Mary's County; of Virginia at Petersburg and City Point; of North Carolina at Magnolia and the Natural Well, Duplin County; of South Carolina, on the Peedee River; Pliocene of the Caloosahatchie marls in south Florida.

This well-known species is characteristic of the true Miocene of the United States eastern coastal plain, only one specimen having been found in the Pliocene, and that may have been derived from a Miocene source. The radiating threads from which the *multilineata* takes its name are variable in number and strength and are formed on a thin outer stratum of the shell, which frequently scales off, leaving a concentric sculpture with no traces of radials. I have no doubt that the two nominal species should be consolidated.

In cleaning out a large *Arca* from the Miocene of Virginia I found a specimen of this species *in situ*, and was able, by using great care, to detach the greater part of the lower valve in fairly good condition, confirming the reference of the species to the genus *Discinisca*. As it is extremely rare to find any trace of the lower valve in the Tertiary marls I have had the remains of this one figured. The valve is as thin as tissue-paper, with, on its upper surface, a low but sharp median septum, extending from just in front of the peduncular foramen to the posterior end of a flat, lanceolate riblet, which in its turn extends forward in the same line, nearly reaching the front margin. The foramen is clean-cut, narrow, and extends nearly to the middle of the

valve, the posterior part being unfortunately defective. As in recent species of *Discinisca,* the valve, viewed from below, is somewhat concave.

Family RHYCHONELLIDÆ.

Genus **HEMITHYRIS** Orbigny.

Hemithyris psittacea Gmelin.

Anomia psittacea Gmelin, Syst. Nat., vi., p. 3349, 1792; Dillwyn, Descr. Cat. Rec. Sh., i., p. 293, 1817.

Terebratula psittacea Lamarck, An. s. Vert., vi., p. 248, 1819.

Hemithyris psittacea Orbigny, Comptes Rendus, xxv., p. 268, 1847.

Rhynchonella psittacea Quenstedt, Handb. d. Petrefactenkunde, pl. xxxv., fig. 44, 1851.

Fossil in the Pleistocene clays of the Gulf of St. Lawrence and New England region as well as the bowlder clays of Alaska and northern Europe. Living in the boreal seas of the whole northern hemisphere, both Atlantic, Pacific, and Arctic.

Genus **RHYNCHONELLA** Fischer de Waldheim.

The following species differ from all the recent *Hemithyris, Atretia,* etc., I have been able to examine in the character of the deltidium. In the type of *Hemithyris* the deltidial plates are widely separated, and in the young are produced dorsally and even sometimes perceptibly recurved laterally. Under these conditions the pedicle extends over an apex of the hæmal or dorsal valve with the deltidial plates at each side extending parallel to each other and the apex of the ventral valve is recurved over them. In the older specimens the projecting deltidial edges appear to be worn away, and what little is added to the plates extends towards the median line.

In the first of the following species (and possibly in both) the deltidial plates approach each other to form an arch, unite in the median line, and project with flaring edges distally, thus forming a tube in which the peduncle is enclosed and to which the beak of the ventral valve contributes a relatively small portion. This arrangement is so different from that which obtains in *Hemithyris* that I hesitate to include the species under that name, but, since the internal characters are not accessible, prefer to list it under *Rhynchonella* until more information shall be obtainable.

Rhynchonella salpinx n. sp.

Plate 58, Figures 5, 6, 7.

Eocene limestone of the city quarry, Wilmington, North Carolina; Vaughan.

Shell small, rounded trigonal, smooth behind, plicate anteriorly; ventral

valve with a prominent, acute, hardly recurved beak, with a small peduncular foramen, the deltidial plates, etc., as above described; hinge-line somewhat flexuous, anterior margin of the valve with a broad double fold produced hæmally, with two or three less pronounced plications laterally; hæmal valve convex, reciprocally plicate; interior filled with a hard matrix; shell structure fibrous. Length 11.0, breadth 9.5, dorsoventral maximum diameter 6.0 mm.

This pretty little species appears to be rare, as only two specimens were obtained.

Rhynchonella Holmesii n. sp.

Plate 58, Figures 10, 11, 12.

Eocene limestone of the city quarry, Wilmington, North Carolina; Vaughan.

Shell small, rounded trigonal when young, much more transverse when adult, smooth near the beaks, plicate in front and over most of the valves; the ventral valve with a small, erect beak with a moderate foramen, the deltidial plates united in front of it; anteriorly the margin is slightly, convexly flexuous, the valve evenly, uniformly, radially sculptured with twelve to fourteen subequal rounded ribs with narrower interspaces; hæmal valve more convex, reciprocally plicate; the ventral valve has no median septum, but the presence of a hard matrix prevents inspection of the interior characters. Length of hæmal valve of an adult 9.5, breadth 11.0, diameter 5.0 mm.; of a ventral valve, length 10.5, breadth 11.5, diameter 3.0 mm.

The specimen figured is a young shell, the adults being more or less fragmentary. It is named in honor of Dr. F. S. Holmes, to whom are chiefly due the fine monographs on the Post-Miocene fauna of South Carolina.

Family TEREBRATULIDÆ.

Genus **TEREBRATULINA** Orbigny.

Terebratulina lachryma Morton.

Terebratula lachryma Morton, Syn. Org. Rem. Cret. U. S., p. 72, pl. x., fig. 11, and pl. xvi., fig. 6, 1834.

Terebratulina lachryma Conrad, Am. Journ. Conch., i., p. 15, 1865.

Eocene limestone of Wilmington, North Carolina; near Charleston and on the Ravenel plantation, South Carolina; in the artesian well at Albany, Georgia, at a depth of two hundred and thirty to two hundred and forty feet, and from the Jacksonian Eocene of Choctaw County, Alabama; Burns.

The Alabama specimens are nearly all more or less flattened by pressure and thus appear wider than those from the Carolinas, but the occasional normal specimens do not differ.

Genus **TEREBRATULA** (Llwyd).

Terebratula wilmingtonensis Lyell and Sowerby.

PLATE 58, FIGURES 14–20.

?Terebratula canipes Ravenel, Proc. Acad. Nat. Sci. Phila., ii., p. 97, 1844; Conrad, Am. Journ. Conch., i., p. 15, 1865.

Terebratula wilmingtonensis Lyell and Sowerby, Quart. Journ. Geol. Soc. Lond., i., p. 431, fig. 6, 1845; Conrad, Checkl. Eoc. Fos. N. Am., p. 33, 1866.

Rhynconella wilmingtonensis Conrad, Am. Journ. Conch., i., p. 35, 1865.

Terebratula demissirostra Conrad, Kerr's Geol. Rep. N. Car., App. A, p. 18, pl. iii., fig. 1, 1875.

Eocene limestone of Wilmington, North Carolina, and vicinity (abundantly); Lyell, Burns, and Vaughan.

The *T. canipes* Ravenel was insufficiently described from a single ventral valve from the Eocene limestone of South Carolina, and was never figured, but so far as its characters are stated they agree well enough with those of this species when full-grown and well plicated. I have little doubt they are identical, yet under the circumstances the name can hardly claim recognition.

This species when young is smooth; sometimes it reaches a good size without marked plication, yet it almost always shows a little. Many specimens have six or seven strong plications covering more than half of the disk.

Terebratula trinitatensis Guppy.

Terebratula carneoides Guppy.

Terebratula lecta Guppy.

Guppy, Quart. Journ. Geol. Soc. Lond., vol. xxii., p. 296, pl. xix., figs. 1, 2, 3, 1866.

The three species above cited are described by Mr. Guppy as obtained from "the gypseous marls containing *Orbitoides Mantelli* and *Nummulina* exposed near the town of San Fernando in Trinidad." The "great development of *Orbitoides Mantelli*" led Mr. Guppy to regard this horizon as lower than the Bowden beds of Jamaica, in which he is doubtless correct. These foraminifera in Florida are rather characteristic of the Vicksburgian, and it is entirely likely that the San Fernando beds may be in an analogous position in the geological column. The types of the species are in the United States National Museum. *T. lecta* has some resemblance to the broader forms of *T. wilmingtonensis,* but on the whole the three species appear to differ from any of the North American Tertiary or recent faunas. The interior is occupied by a hard matrix, so the loops cannot be examined, but either of them might well be a *Liothyrina.*

Barrett reports a *Terebratula,* a *Terebratulina,* and an *Argyrotheca* from

the "newer Tertiary" of Jamaica (letter in the *Critic*, Feb. 1, 1863), but I suspect that he referred to the Pleistocene reef limestones, which might well contain *Terebratula cubensis* Pourtales, *Terebratulina Cailleti* Crosse, and *Argyrotheca lutea* Dall, so abundant in similar situations in the recent fauna.

Terebratula sp. indet.

Miocene marl at Jackson's Bluff, Ocklockonnee River, Florida; Vaughan.

A single specimen, too young to determine the specific characters, was obtained in the marl. It is mentioned here, as hitherto the Chesapeake Miocene has afforded only *Discinisca* among the brachiopods.

Subgenus **CHLIDONOPHORA** Dall.

Valves flattish, radially threaded, with a straight, wide hinge-line and corresponding flat area on the ventral valve, the foramen triangular, open below with very narrow or no apparent deltidial plates; the cardinal process of the hæmal valve appearing externally like the auricles of a minute Pecten, the loop broad, Terebratuloid; the peduncle short with a rosette of long filaments surrounding it where it emerges from the foramen; the brachia with a wide median lobe in the recent type. Type *Terebratulina? incerta* Davidson, Mon. Rec. Brach., i., p. 38, pl. vi., figs. 23–25, 1886. Tropical Atlantic.

This form has the sculpture of *Terebratulina*, the open loop of *Terebratula*, and several features peculiar to itself, so that the late Mr. Davidson and myself were puzzled to suggest its place in the system, he at first referring it to *Muhlfeldia*. As the type appears as early as the upper Cretaceous, it is probably worth segregating from the typical group or such forms as *Liothyrina*.

Terebratula (**Chlidonophora**) **filosa** Conrad.

Terebratulina filosa Conrad, Am. Journ. Conch., ii., pp. 77, 105, pl. ix., figs. 4, 5, 1866.
?Terebratulina gracilis Conrad, Am. Journ. Conch., i., p. 15, 1865; not of Schlotheim, Petrefactenkunde, p. 270, 1820.

Eocene of Alabama (Conrad, 1865); Cretaceous (rotten limestone) of Alabama, at Uniontown, collected by Dr. Showalter, Conrad, 1866; Cretaceous of Texas, Hayden.

From the figures this seems hardly likely to be identical with Schlotheim's species from the Chalk of Europe, yet they are apparently of the same group, to which Bronn also refers *T. rigida* Sowerby and *T. ornata* Roemer. The Texas specimens referred to are identical with those from Alabama. *T. guadeloupæ* Roemer, from his figure, is nearly allied. The appearance of the type

in the recent fauna would seem to indicate that it might be expected in the several horizons of the Tertiary, including the Eocene, where Conrad, on we know not what evidence, placed his *T. gracilis;* yet, as a matter of fact, all the specimens accessible to me are certainly or probably upper Cretaceous.

Genus **ARGYROTHECA** Dall, 1902.

(*Cistella* Gray, 1850, not Gistel, 1848.)

Argyrotheca Schucherti n. sp.

Plate 58, Figure 8.

Miocene marl of Jackson Bluff, Ocklockonnee River, Florida; Vaughan.

Shell small, solid, transverse when young, more rounded when adult; hæmal valve flattish, slightly concavely flexuous mesially; ventral valve convex, with a wide, moderately elevated beak, a very wide subtriangular foramen, with obsolete, narrow, widely separated deltidial plates, and a triangular flat area as wide as the valve; hæmal valve with a straight cardinal margin; internally with a strong, high mesial septum, thicker at the posterior edge; external sculpture of about twenty feeble, ill-defined radial ribs, separated by narrower shallow furrows. Length of adult 7.5, breadth 8.0, maximum diameter 5.3, height of beak above the cardinal margin 1.7 mm.

This species is somewhat intermediate in character between the transverse recent *A. Barrettiana* Davidson, and the narrower, strongly ribbed *A. lutea* Dall. It has not the dentate septum and strong sculpture of the latter, and except when young, like the specimen figured here, is less transverse, and has its septum less near the cardinal margin than the former. It is named in honor of Mr. Charles Schuchert, of the National Museum, whose "Synopsis of American Fossil Brachiopoda" is well known to students of the group.

Genus **PLATIDIA** O. G. Costa.

Platidia marylandica Clark.

Platidia marylandica Clark.

Eocene of the Aquia horizon, Upper Marlboro, Maryland; Clark.

Larger and coarser, but very similar in a general way to the recent *P. anomioides* Scacchi.

Family TEREBRATELLIDÆ.

Genus **TEREBRATALIA** Beecher.

Terebratalia spitzbergensis Davidson.

Terebratula spitzbergensis Davidson, Proc. Zool. Soc. Lond., 1852, p. 72.

Pleistocene of Rivière du Loup, Canada; Uddevalla, Sweden, and Christiania, Norway; living in cold Arctic or abyssal waters from Spitzbergen south

to Cape St. Vincent on the coast of Spain, Iceland, and the Gulf of St. Lawrence, Canada.

The following species are cited as occurring on the Pacific coast in Tertiary beds.

Terebratula nitens Conrad, 1849.

Tertiary of Astoria. This is, perhaps, a young *Laqueus*.

Terebratella Whitneyi Gabb, 1866.

Miocene of Napa County, California, and twenty miles east of Clear Lake on the road from Colusa to the Hot Springs. This is doubtless a *Terebratalia*.

Morrisia Hornii Gabb, 1861.

Pleistocene of Santa Barbara, Heermann. This would now be called *Platidia Hornii*.

Waldheimia Kennedyi Dall, 1874.

Tertiary (Miocene?) of Cerros Island, off the coast of Lower California. This is probably a *Dallina*.

Laqueus Jeffreysi Dall, 1871.

Pliocene of San Diego, California. This specific name was applied to the young form as *Frenula Jeffreysi*. The adult was later called *Laqueus californicus* var. *vancouveriensis* by Davidson in 1887. The receipt of large numbers of the species leads to the belief that it is distinct from the true *californicus* of Koch.

Terebratalia Hemphilli Dall, 1902.

Pliocene of Santa Barbara and of Point St. George, Crescent City, California. An allied or identical species is found in the Pliocene of San Pedro.

Signor A. de Gregorio in his monograph of the Claiborne Fauna (1890) has described a *Terebratulina innovata* and a *Thecidea claibornensis*. It appears that the habitat of neither of these species is definitely known, and even the genus of the supposed *Thecidea*, based on a single dilapidated valve, is uncertain. Before these species can be enumerated as forming part of our Tertiary fauna more information is required.

DISCUSSION OF THE GEOLOGY.

INTRODUCTORY.

THE conclusion of the descriptive text of these contributions to the Tertiary Fauna of Florida and the coastal plain of the Southeastern United States brings us to a point where we may take stock of the additions to geological knowledge involved in these studies.

Before proceeding to the census of the several horizons developed by these researches it is proper to state the circumstances under which material was gathered (so far as they have not already been laid before the reader) and what material has been available.

Besides the personal work of stratigraphical study and paleontologic collecting in the field done by the writer, Mr. Willcox, and Mr. Johnson, reference to which has already been made, I have had the advantage of collections made by several of the Geological Survey staff in some cases with the direct intent of throwing light on the Florida work. Dr. E. A. Smith, State Geologist of Alabama; the Hon. T. H. Aldrich, of Birmingham, Alabama; Colonel Thomas L. Casey, Engineer Corps of the United States Army; Dr. J. W. Spencer, late State Geologist of Georgia; Professor W. B. Clark, State Geologist of Maryland; Professor G. D. Harris, of Cornell University, State Geologist of Louisiana; Dr. E. W. Hilgard, of California, formerly State Geologist of Mississippi; Mr. E. T. Dumble, while State Geologist of Texas; Professor Robert T. Hill, associated with Professor Alexander Agassiz in the geological study of the West Indies; Mr. T. Wayland Vaughan, of the United States Geological Survey, while detached for geological exploration of the island of Cuba, as well as during his work in the United States;—by these and numerous other gentlemen I have been afforded kind coöperation and most important contributions of material for study and comparison. Much of the earlier work was summarized in Bulletin 84 of the United States Geological Survey, and the map included in Part II. is reprinted from that prepared for the Bulletin.

Properly to study the Florida Tertiary implies its comparison and correlation with that of adjacent regions. The knowledge that Professor Harris was working up the Eocene, group by group, rendered it unnecessary to trespass on that field, especially as typical Eocene is not known to occur in Florida. But in all matters of comparison I have had his cordial coöperation. In the opposite direction Professor W. B. Clark, State Geologist of Maryland, was energetically developing the Tertiary of that State with the aid of an enthusiastic group of students. Here also most kindly coöperation was offered and accepted. The Tertiary of New Jersey had already been monographed by Professor R. P. Whitfield, who had had our own material for study, so that in making comparisons I had the benefit of many of his types. The United States National Museum was, fortunately, able to purchase the collection of Antillean fossils made by Mr. J. L. Guppy, one of the most energetic workers in the paleontology of the West Indies, and the types of Gabb were available at the hospitable Museum of the Academy of Natural Sciences at Philadelphia.

Special collections were made in the course of the work at many classical localities for the purposes of elucidation. Mr. Frank Burns spent some weeks collecting from the later Tertiaries of southeastern New Jersey, especially at Shiloh and Jericho, and the writer subsequently made a statigraphical study of the beds at these localities, a summary of which will be found in Bulletin 84, pp. 40–42. Mr. Harris, then acting as my assistant, made a reconnoissance, aided by Mr. Burns, of the Miocene of Maryland, especially the northeastern or older portion. Subsequently Burns made very full collections at Plum Point, Jones Wharf, and Calvert Cliffs, Maryland. Another campaign was carried on on the York and James Rivers, Virginia, classical Miocene ground, followed by collecting trips during which Burns explored the Miocene of Petersburg and Suffolk, Virginia, localities from which Lea, Conrad, and Wagner obtained many of the species they described.

The well-known locality at the Natural Well, Duplin County, North Carolina, was explored by Burns, who obtained a fine series of fossils there, with minor collections from the lower part of the Neuse River and at Wilmington, North Carolina. Here Dr. T. W. Stanton and Mr. Vaughan, of the United States Geological Survey, obtained at times additional valuable material.

The reconnoissance by Mr. C. W. Johnson of the Waccamaw district and the Croatan region of the Carolinas has already been fully discussed in the course of this Memoir * with its important consequences in clearing up con-

* Part II., pp. 201–217, 1892.

fusion of many years' standing. A rather full collection was also made in the Darlington district, and more lately Mr. Earle Sloan, State Geologist of South Carolina, has proffered hearty coöperation.

In Georgia Mr. Burns, under my direction, descended the Altamaha River on a reconnoissance from near Hawkinsville to the sea, and later explorations at Jacksonboro, Screven County, and Shell Bluff on the Savannah River were undertaken by Mr. Vaughan.

In northern Florida Dr. T. W. Stanton contributed important data on the extension of the Miocene. Mr. J. Stanley Brown, of the United States Geological Survey, studied the section on the Flint, Chattahoochee, and Chipola Rivers.* Mr. Burns made exhaustive collections at Alum Bluff, Chipola, and Oak Grove. Other important localities were visited by Mr. Vaughan. The field work done by Mr. Willcox, Professor Heilprin, and the writer in various parts of the peninsula of Florida is already of record.

The Tertiary localities at Gay Head, Martha's Vineyard, and Block Island were visited and studied by the writer,† with the coöperation of Mr. J. B. Woodworth.

Soon after the work began the interrelations between the Oligocene of Florida and that of the West Indies, especially of St. Domingo and Jamaica, compelled attention. Mr. John B. Henderson, Jr., and Mr. Charles T. Simpson, of the United States National Museum, while on a collecting trip to Jamaica, were able to secure a good supply of marl from the well-known locality at Bowden, which when carefully sorted in Washington afforded nearly four hundred species of fossils most important for our comparisons.

Some attention was also paid to the equivalent formations on the Pacific coast, especially the Pliocene of Southern California, the Miocene of California and Oregon, and the Oligocene lignite beds of the Pacific coast, all of which were repeatedly visited by the writer with comparisons in view.

It will be obvious from the above summary of work done that there was an embarrassment of riches rather than any deficiency of material for study, and it is hardly necessary to state that the descriptive part of this Memoir covers only such portions of this material pertinent to our investigations which was actually in hand at the time the text was written; as in the case of the Chipola and Oak Grove collections, many of the gastropods came to hand after that portion of the work was in type, and in the lists which follow from

* Bull. Geol. Soc. Am., v., pp. 140–170, 1894.

† Am. Journ. Sci., 3d Ser., xlviii., pp. 296–301, 1894.

those localities these belated forms appear under their generic names only It may be mentioned here that since Part II. was printed a revision of the small and difficult group of *Pyramidellidæ*, including *Turbonilla, Odostomia,* and other forms, has been brought nearly to conclusion by my assistant in the United States National Museum, Mr. Paul Bartsch, and in making up these lists his study of the fossil species (which prove to be much more numerous than was supposed when Part II. was written) has been utilized to amplify and correct the portions of the lists referring to that group of mollusks.

Special acknowledgment should be made of the work of Mr. Willcox, who has persevered in exploring most inaccessible corners of the peninsula. To him is due the original discovery of the nummulitic beds described by Professor Heilprin. To him also we must ascribe the researches on the western border of the Everglades, the first geological work ever done there, one very interesting discovery being that of the crystalline limerock now forming at the mouths of streams there, by the precipitation from solution, in flocculent form, of the lime dissolved in the fresh water, and which is thrown down by contact with the salt water where the two come together. The rock contains hardly any fossils, and the faces of the crystals are sometimes an inch or more in length.

The mapping out of the distribution of the different geological horizons from many isolated observations, a good number of which were by Mr. Willcox himself, as shown on the map in Part II., taken into consideration with the observations of Shaler and others on the east coast, indicated that the peninsula of Florida has experienced a tilting by which the eastern margin has been elevated between twenty and thirty feet, while the western coast has been depressed about the same amount. This tilting is supposed to have taken place since the Pliocene. To the data of 1891, upon which the above generalization was based, Mr. Willcox has lately added observations which still further emphasize the fact. He finds that, off the streams falling into the Gulf of Mexico from the peninsula in the relatively shallow waters over the submerged plateau to the west, channels cut in the limestone may be traced for some distance. As these channels, too small to make any marked feature on the usual hydrographic chart, could not have been cut since the sea has covered the plateau, the inference is obvious that they were cut before the tilting of the peninsula, when the limestone was above the level of the sea.

Dr. J. W. Spencer has propounded some very startling hypotheses, involving the elevation of some of the Antilles and Florida many thousand feet and their submergence within a comparatively recent period of geological time.

By the researches of Professor R. T. Hill * and Mr. T. W. Vaughan much more light has been thrown on the subject.

I am entirely unable to accept Dr. Spencer's hypotheses; while admitting many of the facts he brings forward, I am convinced that they admit of some other explanation. We find in the Oligocene of Bowden landshells belonging to groups peculiar to and now inhabiting the island of Jamaica, which is sufficient evidence that since the era during which the Bowden marl was deposited the island has never been entirely submerged. With Cuba it may be different, though I can hardly bring myself to believe that the peculiar landshell fauna which is so characteristic of that island can have been evolved since the Pleistocene. However, this question is apart from those we have to consider here.

The proximity of Cuba to Florida and the fact that the adjacent portions are composed of organic limestones, which has long been known, led to the very natural but erroneous inference that Cuba and the peninsula were formerly continuous, and that the Florida Strait had been cut between them by the erosion due to weather and streams, and subsequently by the Gulf Stream.

There is no doubt Cuba has been subjected to great geological convulsions, but that any considerable part of the island has been submerged since the beginning of the Miocene seems extremely doubtful and requires proof not hitherto forthcoming.

According to Mr. Vaughan's observations the great mass of the Tertiary limestones of Cuba are middle and upper Oligocene, ranging from the Chattahoochee to the Bowden or its equivalent. The Vicksburgian and the Miocene are alike absent, no positive identification of Pliocene beds has been made, and the Pleistocene reef rocks do not occur above the sea at a greater height than thirty or forty feet.

The, on the whole, remarkable horizontality of the Floridian strata indicates a freedom from violent changes of level from the time the Peninsular limestone first emerged from the sea. Landshells in the Ocala limestone show that then dry land existed. South of the Suwannee Strait, closed in late Miocene times, there is no evidence of subsequent submersion to any serious extent. Two gentle flexures run parallel with the peninsula, having the lake district between them; a tilting of, at the most, thirty feet, up at the east, down at the west, which may have been contemporaneous with the flexures; and, for the rest, very slow and slight but probably nearly continuous elevation never exceeding one hundred feet and perhaps less than half that, with dry land and

* Bull. Mus. Comp. Zool., xvi., No. 15, pp. 243–288, 1895.

fresh-water lakes constantly existing since the Ocala islands were raised above the sea; such is the geological history of the Florida peninsula. Denudation of the organic limestones by solution rather than erosion is the prominent characteristic of the changes in the surface. Soft, crumbling under the finger-nail, the rocks of the plateau, if lifted five or six thousand feet, as claimed by Dr. Spencer, would have been furrowed by cañons and swept bodily into the sea. Indeed, to me the proposition is inconceivable as a fact and incompatible with every geologic and paleontologic fact of south Florida which has come to my knowledge.

The development of the geological characteristics of the peninsula, the approximate mapping of its formations, are features of the work that has been done during the studies for this Memoir. Another feature which has aroused some comment has been the development of our knowledge of the marine strata which in Florida and its vicinity correspond to the epoch which in Europe has come to be called and recognized, after Beyrich, as the OLIGOCENE.

Lyell and Deshayes in dividing the Tertiary into periods used the percentage of living forms as a criterion, adopting the term Eocene for beds containing three to four per cent. of species surviving to the present day, Miocene for those containing from seventeen to twenty per cent., and Pliocene for those of which forty to fifty per cent. survive. There are several objections to this method of classification, considered as indicating contemporaneity for the strata concerned; the view of species taken by different persons is by no means uniform; the conditions in one region may be more favorable for surviving than in another region at the same time, and the method as stated takes no account of changes of climate or earth movements on a large scale, to which fluctuations in the rate of evolution of living beings must more or less directly conform. However, in practice the omissions have been more or less effectively supplied, and the European time column having been thus worked out, the establishment of synchronism in the scale of other countries, necessarily an approximation only, will be none the less useful because to a certain extent arbitrary.

According to De Lapparent * European geologists are now pretty much agreed in recognizing two great divisions of the Tertiary: 1, the EOGENE system, divided into *Eocene* and *Oligocene* series, corresponding to a state of things still very different both geographically and faunally from the present epoch, and especially including all the nummulitic formations; 2, the NEOGENE

* Traité de Geologie, ed. iv., p. 1409, 1900.

inaugurated in Europe by a great movement of transgression, bringing in, with the flexures of the Alps, conditions resulting in organic transformations leading to the existing fauna and flora. In its turn this system is divided into the *Miocene* and *Pliocene* series.

The Eocene series in Europe terminated by the great earth movements which uplifted the Pyrenees and Appenines and which were accompanied by a recession of the sea at many points on the shores of northern and western Europe.

On the Gulf and southeast Atlantic coast of North America no marked stratigraphic break has been established between the Eocene and Oligocene series. As the studies of the Eocene in this country have chiefly been made in this region, it is not surprising that most American geologists have been prone to minimize the distinctions between the Eocene and Oligocene series. Nevertheless, if the invertebrate fauna is taken into account and all allowances made for the existence of a few indications of transition, the change in the fauna is so marked that physical changes elsewhere must be assumed to account for it, since no other hypothesis has even been proposed. The parallelism between the Eocene faunas of Europe and North America is so close that no ground appears for taking exception to their correlation, which is generally accepted. This was clearly indicated in my "Table of North American Tertiary Horizons," where I state of the Eocene: "In a wide sense it includes both Eocene and Oligocene of the present table, the two not being separated by essential stratigraphic breaks in the Gulf column or by changes in the climatic relations of the fauna." *

In Europe the Oligocene series followed the uplifts above referred to, and the changes which resulted in the elevation of the Alps brought it to a close. Its beginnings were marked by the encroachments of the sea upon the land, forming gulfs or lagoons deeply intersecting the continental region, and even, towards the middle of the epoch, reducing the dry land of middle and western Europe to an irregular group of large islands, while Italy, Southern Russia, and North Germany were completely submerged.

Paleontologically the consequence of these changes—which were accom-

* Eighteenth Ann. Rep. U. S. Geol. Survey, 1896–7, part ii., p. 332, 1898. This, as well as the fact that "Eocene" in the United States Geological Survey nomenclature is the equivalent of "Eogene" of European geologists, seems to have been overlooked by Miss Maury in her thesis on the Oligocene (p. 89) when she states that I use the term Oligocene as coördinate with "Eocene" and "Miocene."

panied by a uniform and mild climate even into the Arctic regions—was the great extension of brackish-water deposits, lake beds, lignitiferous and leaf-bearing strata, while the purely marine sediments were largely peripheral.

In North America, in the coastal region, the series which we have referred to the Oligocene was similarly marked by wide extension of brackish-water sediments about the Mississippi embayment, more or less lignitiferous, with peripheral marine sediments. On the northwest coast a large proportion of the lignite beds are probably referable to this epoch. Until recently distinctive marine Eocene was unknown north of Puget Sound. During the Harriman expedition to Alaska, however, Dr. Palache was fortunate enough to discover much distorted uplifted and broken marine sediments with a fauna which, though small and badly preserved, I was able to recognize as typically Eocene. This occurred on the Alaskan peninsula, and these rocks are certainly below the nearly horizontal unmetamorphosed sediments of the Kenai formation which contain most of the Alaskan lignite beds. The latter pass slowly and without perceptible break or unconformity into marine shallow-water conglomerates and shales carrying a typical marine Miocene invertebrate fauna. These lignite and leaf beds were referred to the Miocene by Heer, but Starkie Gardner and others have shown that they are Eogene. I have described a similar fauna and succession from the northeastern part of the Okhotsk Sea.*

Since the condition of the true Eocene sediments indicates great physical changes here before the deposition of the Kenai beds, and since a reasonable proportion of Miocene forms occur in the plants derived from them, the conclusion that this portion of the boreal lignite-bearing rocks should be regarded as Oligocene is irresistible.

The marine Oligocene sediments of the southern coast are at first characterized by the appearance of vast numbers of foraminifera, the species in some cases identical with European forms referred to approximately the same relative place in the Tertiary column. The organic limestones characterized by the presence of myriads of *Orbitoides* reach a remarkable thickness; the mass of this limestone, which forms the substructure of the Floridian peninsula, has been drilled to a depth of more than two thousand feet without definitely reaching the subjacent Eocene. Towards the end of this sedimentation nummulites make their appearance for the first time in our Tertiary, and the echinoid fauna is so similar to some of that in the European Oligocene as to

* Proc. U. S. Nat. Museum, xvi., No. 946, pp. 471–478, 1893. In this paper, as in other publications of the time, the term Miocene had not yet been discarded.

lead various geologists to the conclusion that a continuous coast or belt of islands must have extended from the Mediterranean region to the Antilles. The thickness and extent of the Vicksburg limestone, stretching from the Floridian region to Costa Rica, and its singular absence from the Antilles, so far as yet identified, taken together with the comparative thinness of the post-nummulitic Oligocene on the Gulf coast and its enormous development in the Antillean region, the north shore of South America, and the region of Middle America south of Mexico, suggest that during the period indicated there was at first a depression of the continental border coincident with elevation of Antillean lands, while during the period of the upper Oligocene these conditions were reversed, the continental sea margin being brought near to, and even, at the Ocala Islands, above the surface of the sea, while a depression of Antillean lands and Middle America permitted the formation of those great bodies of marine limestones and marls for which the upper Oligocene of those regions is so remarkable. As in Europe so in America, lake-beds were formed away from the seacoast, where the bones of Oligocene vertebrates were entombed to serve in the future as convincing evidence of contemporaneous evolution. Again, as in Europe, those changes which elevated the Alps terminated the processes assigned to Oligocene time; so in America the Middle American highlands, the larger Antillean islands, and the peninsular island of Florida were uplifted, the two Americas united, and vast physical changes consummated. Coincidently at the north the boreal coasts were gently depressed and the waters of the Miocene sea extended over the ruins of the Oligocene forests.

As indicated by the changes in the fauna, the physical changes attending the close of the Oligocene were at first slow, allowing a certain element of transition to appear in the Oak Grove or uppermost Oligocene fauna. At the last they appear to have been sudden, at least the change in the fauna on the Gulf coast was absolute and complete. The change was not only in the species and prevalent genera of the fauna, but a change from a subtropical to a cool temperate association of animals. Previously, since the beginning of the Eocene, on the Gulf coast the assemblage of genera in the successive faunas uniformly indicates a warm or subtropical temperature of water, and the sediments uniformly show, from the Jacksonian upward, a yellowish tinge due to oxidation. In the Oak Grove sands come the first indications of a change towards the gray of the Miocene marls. With the incursion of the colder water the change becomes complete. Not only do northern animals compose the fauna, but the southern ones are driven out, some of them surviving in the Antilles to return later. Some change along the northern coast permitted

an inshore cold current to penetrate the Gulf, depositing on the floor of the shallow Suwannee Strait, separating the island of Florida from the continental shore, a thin series of Miocene sediments, which were also carried as far south as Lake Worth on the east coast of Florida and Tampa on the west coast, as shown by artesian borings.

The movement in elevation which ushered in the Miocene continued, probably, during its entire term. It amounted in Costa Rica, according to Gabb, to several thousand feet, and permanently united the two continents.

I concur with Hill in the belief that, whatever changes of level may have taken place since, no discontinuity of the link between North and South America from the Miocene to the present time is probable, and certainly none amounting to a free communication between the two oceans.

The Miocene of the Gulf coast is essentially the older Miocene of Maryland and Virginia. No trace of it appears anywhere in the Antilles or on the Gulf coast west of the Mississippi embayment. The Miocene fauna of the coast of Texas, revealed by the Galveston artesian borings, is of a different stamp, more nearly allied to that of the Pacific coast. It is probable that the wide stretch of the Mississippi water pouring into the Gulf served as a barrier to the westward migration of species of marine invertebrates.

As the elevation culminated, leading to the termination of the Miocene epoch, Florida became united to the continent, the Suwannee Strait was obliterated, and the influx of cold water into the Gulf ceased. Gradually the temperature rose and the exiled subtropical species began to return. The cold current must have been diverted off shore or elsewhere, for a migration northward, during the latter part of the Miocene, of many species and genera belonging in warmer water succeeded in reaching as far as North Carolina along the coast, and some of them even as far as southern Virginia. This is quite a marked element in the Duplin fauna. Some of the northern invaders kept their foothold in the Gulf, became acclimated to the warmer temperature, and survived. It is always easier for a cold-water invertebrate to survive in water warmer than it is accustomed to than for one belonging in warm waters to persist when there is a change to a lower temperature. Brooks' experiments in Chesapeake Bay showed that a fall of two degrees Fahrenheit in the temperature of the water killed all the swimming larvæ of *Ostrea virginica,* but a rise of twice as many degrees would probably only have hastened their development.

After the culmination of the upward movement terminating the Miocene, a slight depression of the continental border and a change in the fauna indi-

cating a still warmer sea-temperature inaugurated the Pliocene. During this period a continuance of immigration of subtropical forms, Miocene exiles and newcomers, is notable. These pushed their way northward, one species, at least, reaching Martha's Vineyard. The records of this extension were partly obliterated by the ice-sheet of the Glacial period and, even as far south as the Carolinas, are very fragmentary. The end of the Pliocene is the beginning of the Glacial epoch. The Pleistocene of Florida shows a change for the cooler and an elimination of the most purely tropical forms from the fauna, but nothing like the clean sweep at the beginning of the Miocene. The latter is the sharpest and most emphatic faunal change since the Cretaceous on our coasts. With the exception of a few widely distributed and uncharacteristic species the entire molluscan fauna of the north shore of the Gulf was swept away and replaced by a more meagre fauna of a different type. In the face of this revolution no proposition to extend the limits of the Miocene farther down the column seems to me defensible.

The above summary of the changes in the period between the Vicksburg and the Glacial epoch was sketched in all its main outlines in Bulletin 84 of the United States Geological Survey in 1891, and amplified in the introductory remarks to my "Table of Tertiary Horizons" in 1895. Subsequent study has only confirmed the views drawn from the earlier work, and, as a whole, the establishment of this general view may be regarded as the most important result of this study of the Tertiary faunas of Florida. A thorough knowledge of the present faunas of the coast is almost essential to enable one to fully recognize the weight of the evidence, but I am convinced that in its main features the above sketch will stand the test of time, even though some amelioration may be expected in minor details.

In some recent papers on the Oligocene and Eocene it has been suggested that the presence or absence of identical species in the Tertiary beds on either side of the Atlantic is an important factor in deciding the correlation of geological horizons. While this is partially true of older geological horizons, after the Mesozoic epoch the faunal characteristics of the shallow-water Mollusca of different regions became rapidly distinctive. Even in the Eocene but two or three species can be claimed as identical on both shores of the Atlantic, and in later periods it would be most unreasonable to demand of subtropical marine invertebrate faunas in widely separated regions that they shall offer a series of identical species on pain of being refused correlation. We cannot ask that they shall do more than present equivalent stages of evolution in relation to preceding and subsequent faunas, or that a no greater number of identical species

shall be required than are found in the contemporaneous faunas of the present day in similar cases. This is undoubtedly true of the faunas treated of in this Memoir.

In the course of the work it became necessary to consider the systematic arrangement of the pelecypoda. The general subject required revision in the light of recent researches, both in anatomy and paleontology. With this view Part III. was devoted to a compilation of existing data, in which material from many sources was brought together and an approximate classification deduced. This paper called attention to the subject, and one of the results was an investigation by Dr. W. G. Ridewood, of the British Museum, into the characters of the gills of this group of mollusks as a basis for their systematic arrangement. This valuable piece of work * has corrected many errors and given much new information based on modern methods of minute anatomical research. It is obviously too soon to decide the general question upon which these observations bear, but, on the whole, from the writer's point of view, they rather support than weaken his previous conclusion that the gills are unsuitable for use as fundamental characters in systematic arrangement.

The description of the several stages or horizons and lists of the species recognized at each now follow.

It will be observed that numerous undescribed species occur in parts of these lists which have come to hand since the work was begun, but too late to be included in the text. Also that some revision of the nomenclature has been made, so that the lists are approximately up to date, comparable with each other, and practically uniform in arrangement.

These lists will be followed by a summary in tabular form showing the relations of the faunas to one another and statistics † of the work covered by the text. It may be mentioned that practically all the types of species de-

* Phil. Trans. Royal Soc. Lond., Ser. B, vol. cxcv., pp. 147–284, 1903.

† It may be of interest to note that during the progress of this work approximately eight thousand three hundred and fifty species have been discussed or compared and eight hundred and sixty new forms described. More than fifty new group-names, from sections to genera, have been proposed and more than five times as many reduced to the rank of synonyms as unnecessary or belated. The number of species known at present between the beginning of the Oligocene and the present fauna is between three and four thousand, probably less than half as many as will eventually be obtained and discriminated. The lists here given have one rather exceptional advantage in that they are all made by one person (the writer), and hence are more strictly comparable than similar lists compiled, as is frequently the case, from diverse sources.

scribed are in the collections of the National Museum at Washington, the Wagner Institute, and the Academy of Natural Sciences of Philadelphia, except where otherwise explicitly stated.

THE VICKSBURG LIMESTONE.

This, the lowest member of the Oligocene in our Southern Tertiary series, has been intelligently discussed by Colonel Thomas L. Casey (Proc. Acad. Nat. Sciences of Phila. for 1901, pp. 513–518), and I can add nothing of consequence to his exposition. It is to be hoped that he will eventually give a monographic account of the stratigraphy and fauna, for which, by his studies on the spot, he is well prepared.

Through the census taken by Conrad, with the addition of a few species since described, we find that the molluscan fauna of the Vicksburg horizon comprises about one hundred and twenty-two species, of which one hundred and two are peculiar to it; about ten are found in the Claibornian and Jacksonian Eocene proper; and possibly a somewhat larger number in the subsequent Red Bluff substage, of which I have not data to give an adequate discussion at the present time.

Of the restricted Vicksburg fauna some fifteen species are known to persist into the Ocala limestone or nummulitic horizon, but as the fauna of the latter is only imperfectly known, the real number of Vicksburg survivals is possibly a good deal larger.

In the second division of the southern Oligocene the lower beds contain an imperfectly preserved fauna which has not been adequately studied, and the first horizon of which the fauna is approximately known is that of the Tampa silex beds. This contains about eight or nine Vicksburg species, and in the Tampa limestone, which conformably rests upon the silex beds, only nine Vicksburg species occur. Only two Vicksburg species have been recognized in the Miocene and persist to the recent fauna.

Colonel Casey, Mr. Aldrich, and others have shown the fallacy of the notion (to which so much confusion may be attributed) that *Orbitoides Mantelli* is a characteristic fossil of the Vicksburgian. It is true that in the lower division of the Oligocene *Orbitoides* is frequently very abundant, but not so (according to Colonel Casey) in the typical bed at Vicksburg. Moreover, a glance at the list given under the head of the Ocala limestone will show that there are several species of *Orbitoides* which have generally been more or less confused with one another and which have been identified for the United States Geological Survey by Dr. Bagg. A careful study and much more extended

collections are needed before the precise distribution of these species in time can be known. There is some question in my own mind as to whether the Jacksonian *Orbitoides*, noted for its larger size and referred to by Colonel Casey, is not the *O. papyraceus* instead of the *O. Mantelli*, but these questions must be solved by an expert in foraminifera.

Colonel Casey recognizes two distinct horizons in the Vicksburg bluff, regarding the two lower strata of O. Meyer as a single faunal group differing from the clayey upper marls by about fifty per cent. of its included species. If this is confirmed by more extended researches, the upper bed should receive a distinctive name. It is in this bed and not the limestone that *Orbitoides* is a characteristic fossil. Colonel Casey also notes in regard to the fossils of Byram Station on the Pearl River that they appear intermediate between the Vicksburgian and Red Bluff, many of the species belonging to the former fauna, while the Byram deposit also contains a considerable number which are peculiar to itself. Doubtless the thorough exploration of these different beds will greatly enlarge the number of recognizable faunas and clear up much that is doubtful at present in regard to the progressive evolution of the invertebrates of our Tertiary.

From the observations on the typical Vicksburgian by Colonel Casey it seems probable that the Orbitoidal limestone which forms the mass of the Floridian plateau, and which has been, in this work and in the literature, generally called the Vicksburg limestone, may really form a different horizon altogether from the typical Vicksburgian and be intermediate between the latter and the nummulitic Ocala limestone. In order to promote clearness and avoid confusion it is probably advisable to adopt a distinct name for the Orbitoidal phase or formation, for which I would suggest the term Peninsular limestone. This is intended, not as a permanent formation-name, but as a general term for the fundamental plateau limestone of Florida, in which a close and thorough study in the future may result in the discrimination of more than one horizon or zone.

For the statistics used in the general table I have been obliged to take Conrad's list of Vicksburg species, with a few additions, making a total number of one hundred and twenty-two. While a considerably larger number are known at present, the proportional relations to other faunas will probably be little changed when a complete list is at our service. Conrad recognized seven species of mollusks as common to the Vicksburg and the Jacksonian; three more are known to me. This is less than nine per cent., and it is quite possible that this proportion will be diminished when the whole fauna of the

Jacksonian and Vicksburg is known. At any rate, the proportion is less than one-third that which unites the Chesapeake Miocene with the typical Pliocene.

THE SHELL BLUFF GROUP.

This supposed group was defined by Conrad, who placed it below the Jacksonian in the Eocene column, as forming the uppermost division of his Medial Eocene, which included the horizons between the Chickasawan and the Jacksonian.* Later it was a subject of discussion, some error being generally suspected. Professor W. B. Clark visited the locality and found above the *Ostrea georgiana* bed a layer of shell limestone composed exclusively of the valves of a species of *Yoldia* which had a more modern aspect than the strata below and was noted by the writer as probably Eocene,† but showing indications of transition towards the Oligocene, then termed Older Miocene. In the "Table of Tertiary Formations" compiled by the writer in 1895 a place was doubtfully indicated for this portion of the Shell Bluff Group in the lower Vicksburgian, it being stated at the time that its position was not definitely settled.‡

In 1900 the locality was visited and carefully examined by Mr. T. Wayland Vaughan, of the United States Geological Survey, who determined the age of the Shell Bluff formation below the *Ostrea georgiana* bed to be practically identical with the Claibornian. The name of Shell Bluff is therefore to be expunged from the column of groups of American Eocene, and relegated to the rank of a mere local development of the Claibornian. Characteristic fossils from Shell Bluff recorded by Mr. Vaughan are *Venericardia planicosta* and *alticostata, Corbula oniscus, Pteropsis lapidosa, Mesalia obruta, Ostrea georgiana, Turbinolia pharetra,* and *Endopachys Maclurei.* Some forty species altogether were collected.§

In this connection it may be observed that the collection of typical specimens of *Ostrea georgiana* Conrad shows that this species, to which large oysters from all parts of the Tertiary have been hastily referred by some authors, is well distinguished when in perfect condition by its surface sculpture. This is characterized by low, flattish, distally forked radial riblets, quite different from anything observable on the surface of *O. mauriciensis* or *O. virginica,*

* Checklist Inv. Fos. N. Am. Eocene, p. 1, 1866.

† Bull. U. S. Geol. Survey No. 84, p. 84, 1892.

‡ Eighteenth Ann. Rep. U. S. Geol. Survey, pt. ii., p. 342.

§ See Science, N. S., vol. xiii., p. 270, Feb. 15, 1901.

which occupy a similar niche in the faunas succeeding the Eocene. As in all oysters, this thin sculptured layer is easily decorticated, and to this fact is largely due the confusion which has existed on the question of the geological range of this species.

THE OCALA LIMESTONE, OR NUMMULITIC ROCK OF HEILPRIN.

This horizon was first discovered by Mr. Joseph Willcox and discriminated from the Peninsular limestone by Professor Angelo Heilprin, who called attention to the contained nummulites, two of which he described as new. It is best developed about the town of Ocala, where it forms the country rock and has been quarried to a depth of twenty feet without reaching its contact with the subjacent Peninsular limestone. The southernmost point where it has been noticed is Pemberton's Ferry, Hernando County, but it has been observed at many points north and west of Ocala and has been recognized at a point five miles south of Jackson, Clarke County, Alabama, where specimens containing the distinctive nummulites were collected by Mr. T. W. Vaughan, of the United States Geological Survey. It seems probable that this limestone was continuous in deposition with the upper part of the Peninsular limestone of Florida, which is generally supposed to belong to the Vicksburgian, and the two are distinguishable only by their contained fauna, the nummulites, a great profusion of other foraminifera, and a certain number of mollusks being characteristic of the Ocala limestone. A detailed account of its distribution is given in Bulletin 84 of the United States Geological Survey, though, as in other cases, the geological conclusions of that work have been modified by later researches to some extent.

The rock at Ocala is a fine-grained, pale-yellow, calcareous sandrock, easily disintegrated when fresh, but hardening somewhat under the influence of exposure to the weather. Except in rare instances the molluscan fossils are only represented by molds and internal casts, which are often very perfect, but difficult to get casts from, owing to the friability of the rock. The principal locality for the material collected by Mr. Willcox is known as Richard's Quarry, and, among other things, bones of a fossil cetacean, perhaps a species of *Squalodon*, were embedded in the soft rock.

The fauna of the limestone appears to be the same as that of a much silicified country rock quarried at Martin, a railway station about ten miles north of Ocala in Marion County. This rock on account of its hardness has been trans-

ported long distances for railway ballast, sea walls, rip-rapping, etc., in many parts of Florida, quantities of it having even reached Charlotte Harbor at Punta Gorda. It contains many pseudomorphs, sometimes admirably reproducing the details of structure of the fossils it once contained.

The following list makes no pretensions to completeness, since the smaller foraminifera remain unstudied and collections were made only incidentally to other work while in transit.

LIST OF SPECIES FROM THE OCALA LIMESTONE.

Those marked O are from Ocala; M, from Martin Station. Those also known from Vicksburg are marked V, while those followed by S are also known from the silex beds of Tampa. An asterisk denotes the survival of the species to the recent fauna.

Aturia (near alabamensis Morton), O.
Helix (Cepolis?) sp., O.
Scaphander grandis Aldrich, O, also Jacksonian.
Conus planiceps Heilprin, M, S.
Drillia servata Conrad, M, S, V.
Cancellaria like alternata Conrad, M.
Eucymba ocalana Dall, O, also Eocene.
Caricella sp., O.
Lyria musicina Heilprin, O, S.
Turbinella polygonata Heilprin, O, S, also Chipola?.
Mitra, like Millingtoni Conrad, O, V?.
Latirus floridanus Heilprin, M, S.
Fusus (Papillina) dumosus Conrad, O, V.
Fusus mississippiensis Conrad, M, V.
Cassis globosa Dall, O, V.
Transovula multicarinata Dall, O, M.
Cypræa Heilprini Dall, O, S, also Tampa limestone.
Cyprædia fenestralis Conrad, O, V.
Strombus sp., M.
Rimella Smithii Dall, O, M.
Cerithium ocalanum Dall, O, M.
Cerithium sp., O.
Serpulorbis granifera Say, O, S.
Turritella var. martinensis Dall, M, O.
Turritella gatunensis Conrad, O, M.
Mesalia? sp., M.
*Xenophora conchyliophora Conrad, O, S, V.
Amauropsis ocalana Dall, O.
Dentalium sp., M.

Leda multilineata Conrad, O, M, V.
Glycymeris subovata Say, M, also Miocene.
Glycymeris sp., M.
Pinna quadrata Dall, O. V?.
Ostrea mauriciensis Gabb, M, S.
Pecten (Æquipecten) perplanus Morton, O, V.
Pecten (Æquipecten) centrotus Dall, O.
Pecten (Chlamys) indecisus Dall, M, V.
Pecten sp., O.
Amusium ocalanum Dall, O, M, V, S.
Plicatula densata Conrad, O, M, V, S.
Crassatellites sp., M, O.
Venericardia sp., near serricosta Heilprin, M.
?Isocardia floridana Dall, Arredondo.
Diplodonta sp., M, O.
Cardium sp., O.
Cardium, two sp., M.

Pitaria astartiformis Conrad, M, V, Chipola.
Corbula sp., M.
Fistularia ocalana Dall, O.
Nummulites Willcoxi Heilprin, O, M, Georgia,* Alabama.
Nummulites floridensis Heilprin, O, M, Georgia, Alabama.
Nummulites Heilprini Hantken, O.
Nummulites Raimondi Defrance, O, Alabama.
Nummulites variolaria Lamarck, O.
Orbitoides Mantelli Morton, O, V, M.
Orbitoides dispansus Sowerby, O, M, Georgia.
Orbitoides sella D'Archiac, O.
Orbitoides papyraceus Boubée, M, Georgia.

The total is about fifty-nine species, of which about twenty-five appear to be peculiar, fifteen are inherited from the Vicksburgian, and eleven persist as far as the silex beds of Tampa. Two Ocala species are present in the Eocene, four as far up as the Chipola, one reaches the Miocene, and one survives to the present day. If the whole fauna were known, doubtless a larger number would be noted as surviving. Hardly any of the smaller species which predominate among survivors from one horizon to another, and which, of course, existed, are among those collected.

The tough limestone replete with Miliolid foraminifera found by Professor Heilprin at Wheeler's, on the Homosassa River, a few miles from the typical nummulitic beds, is probably, as he seemed to infer, a special local phase of the Ocala limestone rather than a deposit of a distinct period of sedimentation.

THE CHATTAHOOCHEE GROUP.

In 1887 Mr. D. W. Langdon, while making geological observations on the Chattahoochee River, noted above the white Orbitoidal limestone a rock more argillaceous and silicious which appears at Rock Bluff, at points near Ocheesee Landing, two miles above, and in a railway cutting about half a mile east of the river at the railway bridge over the Chattahoochee River at New Chattahoochee Landing.† The latter may be regarded as the typical locality, as suggested by Mr. Langdon (*op. cit.*, p. 444), who proposed for this argillaceous limestone (which he states contained a *Pecten* and an oyster resembling *O. virginica*) the name of the Chattahoochee Group, or limestone. He also supplied a section of the strata at Ocheesee, where this limestone, without fossils, has a thickness of ten feet above five feet of the Orbitoidal limestone.

* The Georgia localities are near Bainbridge.

† See observations by Langdon in Am. Journ. Sci., 3d Ser., xxxviii., p. 324, 1889; also in Report on the Geology of the Coastal Plain of Alabama by E. A. Smith, State Geologist, pp. 374–6, 444, 1894.

Mr. Langdon in 1894 apparently intended to include in his Chattahoochee Group all the strata between the Orbitoidal limestone and the Miocene of Alum Bluff, but, as in many other cases, the progress of discovery indicates that it will be necessary to divide the strata referred to into several groups, and so for the lower portion, first described by Langdon, the name he proposed will be properly retained.*

In 1892 the writer (still retaining the term Miocene for the Post-Vicksburgian Oligocene) restricted the Chattahoochee group to that portion of the series included between the nummulitic beds of Heilprin and the Tampa silex beds.†

The discovery of richly fossiliferous marls on the Chipola River by Dr. Frank Burns, of the United States Geological Survey, and various questions which arose in regard to the correlation of the different beds on the Chipola and Chattahoochee Rivers, led to their investigation by the writer and Mr. Joseph Stanley Brown, of the United States Geological Survey, in 1893, and the results appear in the publications of the Geological Society of America.‡ It will be noted that the term "Miocene" is still retained in this paper for the strata comprising the Chattahoochee and Tampa Groups. It is not necessary to recapitulate the conclusions of this paper, which have been in the main confirmed by later observations.

The study of the Antillean beds, which had hitherto been included by authors in the Miocene on account of their similarity in fauna to the Oligocene of Bordeaux and Dax in France (anciently called Miocene), led at once to the correction of the erroneous nomenclature hitherto in use by the writer and others in treating of the continental American beds which by their fauna were obviously related to those of the Antilles, and in some prefatory remarks to a paper descriptive of some Antillean fossils the writer adopted the nomenclature which he has since used in regard to these beds.§

* It is quite probable that Mr. Langdon's valuable contribution to Dr. Smith's Geology of the Coastal Plain was long detained in manuscript before printing.

† Bull. U. S. Geol. Survey No. 84, pp. 112, 157, 1892. The manuscript of this Bulletin had been submitted for printing more than a year earlier, and it finally went to press in the absence of the senior author, who was engaged in field work on the Pacific coast, which may account for some uncorrected typographical errors which disfigure the volume.

‡ Bull. Geol. Soc. Am., v., pp. 147–170, Feb., 1894.

§ Descriptions of Tertiary fossils from the Antillean region. By R. J. Lechmere Guppy and William Healey Dall, Proc. U. S. Nat. Mus., xix., No. 1110, pp. 303–5, 1896.

In the working season of 1900 Mr. T. Wayland Vaughan, of the United States Geological Survey, visited Bainbridge, Decatur County, Georgia, and was fortunate enough to discover a rich coral fauna near Russell Spring, four miles below Bainbridge, on the Flint River.* By means of this fauna he was enabled to make a direct correlation between the lower Chattahoochee beds (lying unconformably on an eroded surface of the Orbitoidal limestone at Russell Spring) and the Oligocene fauna of the island of Antigua. The presence in both of the characteristic genus *Orthaulax* was proved by material received from Antigua and Bainbridge, and the species appears to be not that of the Chipola marls (*O. Gabbi*) or that of the St. Domingo Oligocene beds (*O. inornatus*), but that of the Tampa silex beds (*O. pugnax*). Mr. Vaughan suggests that the Oligocene reefs in the vicinity of Lares, Porto Rico, and of the Serro Colorado, Curaçoa, probably represent the same horizon. Those of Bowden and at least part of those in St. Domingo are younger and correspond more nearly to the Chipola marls and Oak Grove sands of the Floridian series. The generally poor preservation of the Chattahoochee molluscan fossils makes the aid of the corals all the more welcome and important.

Pumpelly has shown † that at the base of the Chattahoochee there is an eroded surface of the Orbitoidal limestone upon which rolled pebbles of the limestone form a conglomeratic layer, upon which occur the reef corals. This is also the result of Vaughan's observations. We have, therefore, a definite unconformity for the base of the Chattahoochee. To determine its upper limit further observations are necessary. The presence of the Tampa species of *Orthaulax* at Bainbridge and Antigua points to the inclusion of the Orthaulax bed in the Chattahoochee rather than in the Tampa or Chipola group, as I formerly supposed. We have not yet any sufficient list of molluscan or other invertebrate fossils from the Chattahoochee limestone. Mr. Vaughan's list of corals is still awaiting publication, but of the main facts established by it and above summarized there seems no reason to doubt.

Professor G. D. Harris has determined that near Oak Grove, Florida, the typical Grand Gulf sandstones "pass under the Oak Grove sands, thus indicating that the sandstone is of approximately the same age as the Chattahoochee." ‡ This agrees with the earlier observations of E. A. Smith, who says: "The barren Grand Gulf sands pass towards the east into the marine

* See Science, N. S., xii., pp. 873–75, Dec. 7, 1900.

† Am. Journ. Sci., 3d Ser., xlvi., pp. 445–7, 1893.

‡ See Bull. Am. Paleont., iii., No. 15, p. 70, 1902.

deposits of the Chattahoochee, which are their time equivalent" (p. 17), and "The underlying division of the Grand Gulf . . . its position is identical with that of the Chattahoochee limestone of Mr. Langdon, and there is no room for any reasonable doubt about their identity in age" (p. 106).* Having coöperated with Dr. Smith by studying his collections of fossils and furnishing data as to their identification (as he generously acknowledges in the work cited), the writer can only express his concurrence in the learned Doctor's opinion.

There has, however, as in so many other cases, been some confusion in the literature in regard to the so-called "Grand Gulf beds," due to too great inclusiveness of beds lithologically similar but which by their contained fossils are shown to belong to different horizons, some even widely separated. Mr. Langdon † rather amusingly complains that the authorities were at that time "apparently more interested in making long checklists of fossils and describing new species than in recording the character of the strata from which the fossils were collected." Some, at least, of the authorities have done their best to "record the character of the strata," but it has been far more necessary to obtain a careful and complete census of the fauna in each stratum than to describe any number of beds of marl lithologically.

With beds composed of similar materials and often from the *rémanié* substance of the bed preceding, it is practically impossible to form any sound judgment of the geological position of any given stratum in that region without a knowledge of its fossils. If we were so fortunate as to possess a full knowledge of the extinct faunas of the coastal plain nothing would be easier than to settle its geology once and for all time to come. Pending an approximate knowledge of those faunas we can only struggle along, making our checklists, describing the new forms, and working towards the desired end.

The Grand Gulf sandstone was named by Wailes,‡ and its typical outcrop is at Grand Gulf, Claiborne County, on the banks of the Mississippi about a mile below the mouth of the Big Black River and immediately above the town of Grand Gulf, where it forms a bold promontory against which the current sets in great force, creating a dangerous whirlpool or eddy which gave name to the place. A carefully detailed section and photograph of the Bluff are given by Miss Maury in her thesis on the Oligocene of Europe and the United

* Geol. of the Coastal Plain of Alabama, 1894.

† Ibid., p. 375.

‡ Agriculture and Geology of Mississippi, p. 216, 1854.

States.* This being the type locality, the name must be restricted to such beds as are definitely homologous with those at this place, not merely in lithological composition, but in age and relative position. For other formations, however lithologically similar, the name should be rejected as being a source of confusion, misunderstanding, and error.

The true Grand Gulf beds in Mississippi, according to Miss Maury, contain abundant remains of palms, deciduous and coniferous trees. A cast of a *Unio* and other fresh-water bivalves and portions of the shell of a tortoise are the other recorded fossils. In Louisiana, on the other side of the alluvial plain of the Mississippi, these beds reappear and pass across the State in a southwesterly and westerly direction into Texas. Very recently in Grand Gulf beds, at Chalk Hills near Rosefield, Louisiana, Professor Harris found a number of Unionidæ in a layer only five or six inches in thickness. They are in the form of casts very much distorted, so that their nature is barely recognizable. They are associated with leaves of willow, birch, and other deciduous trees. Two species of *Unio* and one of *Anodonta* have been described from this formation by Miss Maury.

The present distribution of the successive Oligocene strata does not give any satisfactory evidence of a marked embayment in the vicinity of the Chattahoochee thalweg. Doubtless there was a small sinuation of the coast, but nothing distinctive, as may be seen by consulting Miss Maury's map. The brackish-water perezone seems a mere extension of that characteristic of the Mississippi embayment. An immense drainage has been persistent here during the greater part of Tertiary time, gradually extending its southern border seaward from the continental shores. At its eastern extreme, which is mapped about one hundred and fifty miles westward from the Chattahoochee, it merges with the contemporaneous marine sediments. And this continues from the base of the Chattahoochee Group to the upper Miocene or lower Pliocene, a period perhaps of millions of years, during which there were two almost complete replacements of the fauna, indicating profound geological changes in the vicinity of the continent. During this period the two Americas were united, the continental shore advanced to the Floridian archipelago, great ocean currents modified in their courses, and almost the whole congregation of warm-blooded terrestrial vertebrates evolved. A geological view which would unite under the name of one formation or group the sediments which were laid down during a stretch of geological time including such extraordinary changes

* Bull. Am. Pal., iii., p. 75, 1902.

seems to the writer inadvisable. Happily, here and there, even with our present most imperfect knowledge of the strata concerned, we have hints which enable us to make approximate correlations. Such are the occurrence of characteristic Chipola species at Roberts, Escambia County, Alabama, of plants similar to those occurring above the Chipola at Alum Bluff, in the "Hattiesburg phase" of the "Grand Gulf," and the presence of upper Miocene or lower Pliocene brackish-water species near Vernal, Greene County, Mississippi, at Shell Bluff on the Pascagoula River, later rediscovered in artesian well diggings at Biloxi, Mississippi, and Mobile, Alabama. These clays were named by Mr. L. C. Johnson, of the Alabama State Geological Survey, the "Pascagoula formation," and his conclusion in regard to them * was that it was represented at Alum Bluff, Florida, by the uppermost (Chesapeake) Miocene of the latter locality. The species found in the clays at the typical Pascagoula locality were *Ostrea virginica, Rangia Johnsoni, Mulinia lateralis,* and fragments of a *Hydrobia* which was described from the Mobile well as *H. mobiliana.* The borings at or near Mobile have, according to Mr. Aldrich, furnished about ten other species, mostly new and of brackish-water habit. According to Messrs. Smith and Aldrich, an extension of borings in the Bascom Well, Mobile, Alabama, to a depth of fifteen hundred to fifteen hundred and fifty feet brought up, as might have been predicted, fossils of the Oak Grove horizon, the eight hundred and fifty feet corresponding to the section of the lower part of the Pascagoula, the whole of the Chesapeake Miocene, and the Oak Grove sands. Of the twelve molluscan species identified from this depth one is known from the Tampa silex beds, three from the Chipola, four from Oak Grove, three range from Chipola or Chesapeake to recent, one is upper Miocene, and one only known from Pliocene to recent. As only too often happens with such borings, unless supervised by an expert, there is probably some mixture here, but, on the whole, the list points to the base of the Oak Grove sands as the probable horizon finally reached. In the communication to "Science" from which I gather the above data † Messrs. Smith and Aldrich express the opinion that the "Grand Gulf" must be "either Pliocene or more recent," and perhaps "Post-Tertiary," while the Pascagoula "will eventually turn out to be Pliocene." In a subsequent communication to "Science" ‡ I pointed out that the confusion into which the subject had fallen is removed by recognizing the

* Report on the Coastal Plain of Alabama, p. 97, 1894.

† Science, N. S., xvi., p. 835–7, Nov. 21, 1902.

‡ N. S., xvi., pp. 946–7, Dec. 12, 1902.

different ages of different parts of the rocks classified as "Grand Gulf," as had already been done by Hilgard. The Pascagoula clays are certainly not older than the upper part of the Miocene, and might very well prove to be Pliocene, but the color of the clays and the indications of the few species known, though not conclusive, rather point to the cooler Miocene than the warmer Pliocene.

In the future the progress of geology would probably be facilitated by dropping the name "Grand Gulf" in all cases except where the typical rocks, such as those at the original locality, are concerned, and referring to the others above recognized simply as the "Roberts sand," the "Hattiesburg clays," and the "Pascagoula clays," with the following approximate correlations: *

Perezonal.	Marine.
Pascagoula clays.	Chesapeake Miocene.
Hattiesburg clays.	Alum Bluff sands.
Roberts sand.	Chipola marl.
Grand Gulf sandstone.	Chattahoochee limestone.

THE TAMPA SILEX BEDS.

This interesting horizon of the Chattahoochee group has been known since 1846, when Conrad described a few fossils from it. It was fully described (though under the caption of "Miocene," now discarded) in Bulletin 84 of the United States Geological Survey. In the first volume of these Transactions Professor Heilprin described a number of species from the "*Orthaulax* bed," and since that time assiduous collecting has added a large number, which have been described and figured in the several parts of this volume. The number of species now known from it is one hundred and ninety-three. The same horizon, characterized by *Orthaulax pugnax* and other remarkable species, has been recognized in Antigua and in Georgia near Bainbridge on the Flint River by Mr. Vaughan. The beauty of the silicious pseudomorphs has led to their being collected as "curios" for sale to tourists. The heavy heads of coral, often geodic and with their interior cavity lined with exquisite crystals of ferruginous red, white, yellow, blue, and various shades of brown, have been in especial demand, and the supply seems to have become entirely exhausted. The establishment of a great winter hotel a few minutes' walk from the out-

* Certain apparently Pleistocene superficial beds on the Gulf coast containing fossil shells have recently been supposed to be "Grand Gulf" by a singular misapplication of this name, in which connection consult Bull. U. S. Geol. Survey No. 84, p. 160.

crop has made it easy for any tourist to search the beach, and it may be said that the days of profitable collecting at Ballast Point are over, as the supply of pseudomorphs is dependent upon the slow disintegration by sea and air of the limestone in which they are contained. The same rock in a more solid and refractory condition extends under the channel off the point, and the engineering operations for deepening this channel brought up large masses of it, from which a few species were obtained at the cost of much labor. Probably boiling pieces of the rock in hydrochloric acid might result favorably.

About forty-nine per cent. of the species in the *Orthaulax* bed are peculiar to it, and very few of the more minute forms which should be present in such a fauna are known. The relations of the fauna are most intimate with that of the Oligocene beds above it, the Orbitolite or Tampa limestone, the Chipola, and the Oak Grove sands. With either of these the percentage of species common to both is more than twice as great as with any of the beds below, such as the nummulitic, the Peninsular limestone, or the Vicksburg. But it must be admitted that the faunas of all these, except the last, are very imperfectly known. With the faunas of horizons above the Oak Grove sands there is little in common, though in the tropical waters of the Antilles about eight per cent. of the species are believed to survive to the present day. Only about 2.6 per cent. survive except in tropical waters.

One of the most interesting features of the fauna is the assembly of land shells, which are southern immigrants and have left no survivors on the American continent at the present day, though representative species occur to the southward.

LIST OF TAMPA SILEX BED FOSSILS.

Those unmarked are from the outcrops at Ballast Point, Tampa Bay, and the shore of the peninsula of which Ballast Point is the extremity. Those marked C are from the rock, presumably of the same horizon, dredged up in deepening the ship channel near Ballast Point. Those marked T are from a locality fifteen miles south of Tallahassee on the railway to St. Mark's in Wakulla County, near Wakulla, collected by Mr. T. Wayland Vaughan. * also recent.

LAND AND FRESH-WATER PULMONATES

Bulimulus (Hyperaulax) floridanus Conrad.

Bulimulus (Hyperaulax) Heilprinianus Dall.

Bulimulus (Hyperaulax) americanus Heilprin.

Bulimulus americanus var. partulinus Dall.

Bulimulus americanus var. laxus Dall.

Bulimulus (Hyperaulax) Stearnsii Dall.
Helix (Cepolis) latebrosa Dall.
Helix (Cepolis) instrumosa Dall.
Helix (Cepolis) crusta Dall.
Helix (Cepolis) crusta var. cunctator Dall.
Helix (Cepolis) diespiter Dall.
Helix (Cepolis) direpta Dall.
Helix (Cepolis) haruspica Dall.
Helix (Polygyra) adamnis Dall.
Eostrophia anodonta Dall.
Eostrophia anodonta var. floridana Dall.
Urocoptis floridana Dall.
Planorbis Willcoxi Dall.

MARINE SPECIES.

Tornatina Wetherilli Lea.
Utriculus vaginatus Dall.
Scaphander primus Aldrich.
Bulla petrosa Conrad.
*Terebra (Oxymeris) dislocata Say, var.
Terebra (Oxymeris) tantula Conrad.
Conus planiceps Heilprin.
*Pleurotoma albida Perry.
Pleurotoma servata Conrad.
Drillia sp. ind.
Drillia Lapenotierei Dall.
Drillia (Cymatosyrinx) Newmani Dall.
*Drillia ostrearum Stearns, var.
Cancellaria (Trigonostoma) subthomasiæ Dall.
Olivella lata Dall.
Ancilla Shepardi Dall.
Marginella ballista Dall.
Marginella tampæ Dall.
*Marginella limatula Conrad.
*Marginella bella Conrad, and var. bellula Dall.
Marginella faunula Dall.
Marginella elegantula Dall.
Marginella Newmani Dall.
Marginella sp. ind.
Lyria pulchella Sby.
Lyria zebra Heilprin.
Lyria musicina Heilprin.
Mitra silicata Dall.
Conomitra staminea Conrad.
Turbinella polygonata Heilprin.
Vasum subcapitellum Heilprin.
Latirus floridanus Heilprin, also T.
Latirus multilineatus Dall.
Latirus rugatus Dall.
Latirus callimorphus Dall.
Busycon spiniger var. tampaënse Dall.
Busycon spiniger var. perizonatum Dall.
Busycon stellatum Dall.
Melongena sculpturata Dall, also T.
Melongena sculpturata var. turricula Dall.
Solenosteira inornata Dall.
Fusus ballista Dall.
Fusus quinquespinus Dall.
Fusus nexilis Dall.
Tritonidea pauper Dall.
Phos, two sp. indet.
Astyris turgidula Dall.
Murex mississippiensis Conrad.
Murex trophoniformis Heilprin.
Murex larvæcosta Heilprin.
Murex crispangula Heilprin.
Murex Burnsii Dall.
Murex (Pteropurpura) Posti Dall.
Muricidea spinulosa Heilprin.
Muricidea sp. ind.
Coralliophila magna Dall, also T.
Rapana tampaënsis Dall.
*Eulima conoidea Kurtz and Stimpson.
Cypræa pinguis Conrad.
Cypræa Heilprini Dall.

Orthaulax pugnax Heilprin.
Lambidium domingense Sowerby.
Strombus chipolanus Dall.
Bittium priscum Dall, also T(?).
Cerithium hillsboroënsis Heilprin, C.
Cerithium georgianum Lyell and Sowerby, also C.
Cerithium præcursor Heilprin, also T.
Cerithium sp. ind., also T.
Potamides hillsboroënsis Heilprin, var., T.
Potamides (Lampanella) transecta Dall.
Potamides (Pyrazisinus) campanulatus Heilprin, also T.
Potamides (Pyrazisinus) cornutus Heilprin, also T.
Trichotropis (Cerithioderma) sp. ind.
Modulus turbinatus Heilprin.
Cæcum solitarium O. Meyer.
Serpulorbis granifera Say.
Serpulorbis ballistæ Dall.
Petaloconchus varians Orbigny.
Petaloconchus sp.
Siliquaria vitis Conrad.
Turritella tampæ Heilprin.
Turritella tampæ var. tripartita Dall.
Turritella pagodæformis Heilprin.
Turritella gatunensis Conrad.
Turritella megalobasis Dall.
Lioplax floridana Dall.
Rissoina sp. ind.
Crucibulum constrictum Conrad.
*Calyptræa trochiformis Lamarck.
Amalthea pygmæa Lea.
Amalthea Willcoxi Dall.
*Xenophora conchyliophora Born.
Natica (Cryptonatica) floridana Dall.
Polynices (Lunatia) hemicryptus Gabb.
Ampullina streptostoma Heilprin, also T and C.
Ampullina amphora Heilprin, also C.
Ampullina solidula Dall.
Amauropsis Guppyi Gabb var. floridana Dall.
Sigaretus chipolanus Dall.
Turbo crenorugatus Heilprin.
Astralium sp., T.
Chlorostoma (Omphalius) exoletum Conrad, also T.
Calliostoma metrium Dall.
Margarites tampaënsis Dall.
Liotia (Arene) solariella Heilprin.
Liotia (Arene) coronata Dall.
Helicina ballista Dall.
Helicina ballista var. tampæ Dall.
Nerita tampaënsis Dall.
Ischnochiton tampaënsis Dall.

Leda flexuosa Heilprin.
*Arca umbonata Lamarck.
Barbatia marylandica Conrad.
Barbatia irregularis Dall.
Barbatia arcula Heilprin.
*Barbatia (Acar) reticulata Gmelin.
Scapharca hypomela Dall.
Scapharca latidentata Dall.
Ostrea sellæformis Conrad var. rugifera Dall.
Ostrea mauriciensis Gabb, var.
Pecten (Æquipecten) chipolanus Dall.
Spondylus chipolanus Dall.
Spondylus bostrychites Guppy.
Plicatula densata Conrad.
Anomia microgrammata Dall.
Modiolus silicatus Dall.
Modiolus (Brachydontes) grammatus Dall.
Modiolus (Gregariella) minimus Dall.
*Modiolus (Botula) cinnamomeus Lamarck.
*Lithophaga antillarum Orbigny.
*Lithophaga nigra Orbigny.
Lithophaga nuda Dall.

*Lithophaga (Myoforceps) aristata Dillwyn.
*Lithophaga (Diberus) bisulcata Orbigny.
Coralliophaga elegantula Dall.
Crassatellites deformis Heilprin.
Cyrena pompholyx Dall, also C.
Villorita floridana Dall, C.
Venericardia serricosta Heilprin, also C.
Cardita (Carditamera) tegea Dall.
Chama chipolana Dall.
Chama tampaënsis Dall.
Codakia sp., also Chipolan.
Myrtæa vermiculata Dall.
Phacoides domingensis Dall.
Phacoides (Here) wacissanus Dall, also Wacissa, Florida.
Phacoides (Cavilucina) recurrens Dall.
Phacoides (Lucinisca) calhounensis Dall.
Phacoides (Miltha) hillsboroënsis Heilprin.
Diplodonta alta Dall.
Cardium (Trachycardium) delphicum Dall.
Cardium (Trachycardium) bowdenense Dall.
Cardium (Trachycardium), two sp. indet.
Cardium (Cerastoderma) phlyctæna Dall.
Cardium (Cerastoderma) taphrium? Dall.
Cardium (Trigoniocardia) alicula Dall.
Dosinia chipolana Dall.
Macrocallista acuminata Dall.
Callocardia (Agriopoma) sincera Dall.
Cytherea tarquinia Dall.
Cytherea (Artena) glyptoconcha Dall.
Cytherea (Artena) Shepardi Dall.
Chione (Lirophora) ballista Dall.
Chione (Chamelea) nuciformis Heilprin.
Chione (Chamelea) spada Dall.
Chione (Chamelea) rhodia Dall.
Anomalocardia floridana Conrad.
Venus halidona Dall.
Tellina segregata Dall.
Tellina merula Dall.
Tellina (Merisca) halidona Dall.
Macoma irma Dall.
Semele silicata Dall.
Corbula (Cuneocorbula) Burnsii Dall.
Corbula sarda Dall.
Panopea Whitfieldi Dall.
Gastrochæna (ovata Sowerby var.?) rotunda Dall.

Orbitolites complanatus Lamarck.

WHITE BEACH, LITTLE SARASOTA BAY.

This formation is at the water's edge, near the northern end of the bay, and is partly covered at high water. It is a coarse, calcareous rock, in which the shells are represented by molds in the rock or by calcareous pseudomorphs which have filled these molds after the latter had been more or less distorted, and from which the surrounding limerock has been weathered away after the formation of the pseudomorph. The body of the rock contains nothing but molds; the surface, when subject to percolation, alone exhibits the pseudomorphs. The original rock seems to have been a coquina without any silicious sand in it, which became a yellowish limestone which was then somewhat crushed and near the surface infiltrated. There are traces of an unusual quantity of polyzoa, corallines, wormtubes, etc., which seem to have grown over

the coquina or assisted in knitting it together. The visible part of this rock is about three feet thick and the top is more or less covered with a recent æolian sand rock which is destitute of fossils or nearly so and is hard enough to ring under the hammer. The specimens are mostly in very poor state, yet occasionally one finds a tolerably perfect pseudomorph, and some of the species are recognizable. The curious reproductions of the corallines, though often very elegant, are not in a state to describe, so much of the original form having been lost in the process. The most conspicuous fossils are the internal casts of a large oyster, but Mr. Willcox and the writer succeeded in obtaining identifiable specimens or molds of the following species, many more species being represented in a state which forbids complete identification. There are no traces of any silicification in this rock, a fact which is notable on account of the prevalence of such action in most of the Floridian limestones.

LIST OF THE WHITE BEACH FOSSILS.

Those which are identified from other horizons are marked: C for Chipola, D for St. Domingo, B for Bowden, S for the Tampa silex beds, etc.; * recent.

Conus demiurgus Dall, C.
Ancilla Shepardi Dall, S.
*Marginella limatula Conrad, S.
Vasum haitense var. engonatum Dall, C, D.
Fasciolaria Sparrowi Emmons, C, also Miocene.
Mazzalina costata Dall, C.
Cypræa Willcoxi Dall, C.
Cypræa pinguis Conrad, S, also Eocene.
Vermicularia sp.
Serpulorbis sp.
Siliquaria vitis Conrad, S, also Eocene.
Modulus turbinatus Heilprin, S.
Natica (near plicatella Conrad).

Leda sp.
Glycimeris americana Defrance?.
*Arca umbonata Lamarck, S, C.
*Scapharca auriculata Lamarck, B.
Scapharca hypomela Dall, C.
Ostrea trigonalis Conrad, Jacksonian to Pliocene.
Ostrea trigonalis var. like procyon Holmes.
Pecten (near Burnsii Dall).
Pecten (Nodipecten) condylomatus Dall, C.
*Pecten (Nodipecten) nodosus Linné, D.
Pecten (Chlamys) near Kneiskerni Conrad, C.
Pecten (Chlamys) sp.
Spondylus bostrychites Guppy, S, D, B.
Lima (near tampaënsis Dall).
Mytilus pandionis Dall.
Crassatellites deformis Heilprin, S.
Cyrena? sp.
Venericardia serricosta Heilprin, S.
Phacoides, near dominguensis Dall.
Cardium (Trachycardium) sp.
Cardium (Trachycardium), near cestum Dall.

Cytherea cæsarina Dall, C.
Cytherea (Ventricola) Blandiana Guppy, B, C.
Pitaria (Lamelliconcha) planivieta Guppy, B.
Chione Woodwardi Guppy, B, D.
Chione Walli Guppy, B.

Total, thirty-nine species, of which twenty-six are fairly well identified species. Two of these are known only from this horizon; four are believed to survive to the recent fauna, another to the Miocene, and one to the Pliocene. One appeared as early as the Claibornian, and three by Jacksonian time. Twelve of the identified species are also known from the Chipolan horizon, nine from the silex beds, six from Bowden, and four from the Haitian Oligocene.

The indications of the fauna may be summed up as pointing to a close alliance to that of the Chipola and Ballast Point horizons, in all probability indicating a stage above the latter and below the former.

TAMPA LIMESTONE, OR ORBITOLITE BED.

This stratum is superimposed upon the silex beds of Ballast Point, Tampa Bay, where it may be eighteen inches thick, and extends inland and northeastward. It underlies the city of Tampa, where wells are dug through it, reaching water at a depth of ten feet or thereabouts, the cherty stratum of the silex beds probably serving as a water-table below. The same rock occurs seven miles northeast of Tampa in wells and also on land (S.E. ¼ Section 14, T. 29, R. 19) near Orient Station on the railway. Its upper surface is about fourteen feet above the water of Six-Mile Run (or Creek), near by, and about twenty-five feet above the mean level of the sea at Tampa, at the railway wharf, according to late surveys. Its thickness varies more or less in different places, and its greatest thickness I was unable to determine, but suspect it does not exceed twenty feet. The same rock is reported to occur on the Manatee River above Braidentown, and I observed it still farther to the south and west in 1887, about one mile from Sarasota village, on the road from Braidentown, in the gully of a small rivulet about half a mile from the shore of the bay. This rock, which is obviously younger than the silex beds, was referred by Heilprin to the "Yorktown" epoch of Dana or middle Miocene.

The character of the rock is that of a limestone free from silex, of a loose and porous texture and pretty uniform appearance and consistency. The fossils are mostly represented by external molds, but a few, and particularly the Orbitolite described by Conrad, retain their structure. Many of the fossils of the silex beds appear in the Orbitolite bed, but there is a notable absence of the large corals so common in the lower stratum, and various new forms appear

while older ones have in numerous cases disappeared and in others have changed their proportional representation in the rock as compared with other members of the fauna.

LIST OF FOSSILS OF THE TAMPA LIMESTONE.

Those from the Orbitolitic limestone above the silex beds, on the peninsula of which Ballast Point forms the extremity, are marked B; those from the limestone at Jacksonboro', Screven County, Georgia, are marked J. The asterisk denotes that the species is also known in the recent state. Species obtained from wells sunk in this limestone in the town of Tampa are marked A; those from Six-Mile Run are indicated by C; those from a well seven miles northeast from Tampa are marked D, and those from near Orient by E. Those marked F are from a well three and a half miles northeast of Tampa.

Bulimulus (Hyperaulax) americanus Heilprin, B.
Tornatina Wetherilli Lea, A, E, F, B.
Scaphander grandis Aldrich, D.
Scaphander primus Aldrich, A, E, J.
Bulla petrosa Conrad, D, J.
Bulla, two sp., J.
Conus planiceps Heilprin, A, C, D, E, F.
Pleurotoma servata Conrad, J.
Pleurotoma sp., J.
Drillia sp., J.
Olivella lata Dall, B, E.
Ancilla Shepardi Dall, F.
Marginella bella Conrad, A.
Mitra n. sp., J.
Conomitra staminea Conrad, C. F.
Vasum subcapitellum Heilprin, B.
Melongena sculpturata Dall, E.
Latirus floridanus Heilprin, F.
Solenosteira inornata Dall, B, C, D.
Busycon spiniger Conrad, var., B, F.
Busycon stellatum Dall, A.
Fusus sp., C, D.
Fusus (Papillina) dumosus Conrad, var.? A, B, C, D, E.
Cypræa Heilprini Dall, C, D, F.
Strombus albirupianus Dall, J.
Cerithium georgianum Lyell and Sowerby, B, J.
Cerithium platynema Dall, B, J.
Cerithium n. sp., J, also at Wakulla, Florida.
Potamides hillsboroënsis Heilprin, B.
Potamides (Pyrazisinus) cornutus Heilprin, B, J.
Potamides (Pyrazisinus) acutus Dall, B, J.
Potamides (Pyrazisinus) n. sp.? J.
Bittium sp.? B, F.
Modulus turbinatus Heilprin, J (also silex beds).
Turritella tampæ Heilprin, J, F.
Turritella (near megalobasis Dall), A, C, F.
Turritella sp., C, D, E, F, J.
Calyptræa trochiformis Lamarck?, J.
Amalthea sp., J.
*Xenophora conchyliophora Born, B, C, J (X. humilis Con.).
Ampullina streptostoma Heilprin, A, C, D, F, J.
Ampullina amphora Heilprin, B.

Amauropsis ocalana Dall.
Acmæa sp., J.
Helicina ballista Dall, var. tampæ Dall, B, C.
Nerita tampaënsis Dall, B.
Fissuridea sp., J.
Dentalium mississippiensis Conrad, J (also Vicksburg).

Nucula (near proxima Say), F.
Leda flexuosa Heilprin, B.
*Arca umbonata Lamarck, A, D.
Arca arcula Heilprin, F.
Arca (Scapharca) sp., A, C, E.
Arca (Scapharca) sp., B.
Arca (Fossularca) sp., A.
Glycymeris (cf. jamaicensis Dall), B, C, F.
Ostrea sp. (young), B.
Pecten (Chlamys) sp., A.
Pecten (Chlamys) sp., A, E.
Pecten (Chlamys) sp., E.
Pecten n. sp., J.
Mytilus n. sp.? J.
Mytilus sp., B, E.
Modiolus (Brachydontes) sp., J.
Botula (cf. cinnamomea) sp., A, F.
Lithophaga nuda Dall, A, C, D, E.
Coralliophila sp.? C.
Venericardia serricosta Heilprin, A, B, C, D, E, F.
Venericardia sp., B, C.
Chama Lyelli Dall, J.
Chama tampaënsis Dall, C.
Phacoides sp. (cf. domingensis Dall), J.
Phacoides (Miltha) hillsboroënsis Heilprin, var.? B.
Lucina (cf. janus Dall), B.
Diplodonta alta Dall, var.? A, C, E.
Cardium delphicum Dall, var.? B, C, F.
Cardium eversum Conrad, var.? J.
Cardium (cf. virile Dall) sp., D.
Cardium (cf. chipolanum Dall), A.
Cytherea tarquinia Dall, A.
Cytherea (Artena) glyptoconcha Dall, A, B, D, F.
Chione (Chamelea) nuciformis Heilprin, B, F.
Chionella sp.? B, C.
Venus halidona Dall, A, B, C, D, E, F.
Anomalocardia floridana Conrad, A, B, C, D, E, F.
Tellina merula Dall, var.? J.
Tellina sp., B, J.
Macoma irma Dall? B.
Macoma, two sp., J.
Semele silicata Dall, var.? C, D, F.
Psammosolen (cf. vicksburgensis Conrad) sp., J.
Corbula (cf. seminella Dall) sp., E.
Orbitolites complanatus Lamarck, A, C (O. floridana Conr.).
Orbitoides n. sp., J.

Total, ninety-five species, of which thirty-six are uncertain specifically, leaving fifty-nine identified, of which thirty-seven are common to the silex beds, ten are peculiar to the Tampa limestone horizon, four are known from the Ocala nummulitic limestone, and two appear in the Vicksburgian, the Jacksonian, and the Claibornian. One species (and probably more not yet discriminated) survives into the Chipola and two are believed to persist to the recent fauna.

JACKSONBORO' WHITE LIMESTONE.

The limestone of the vicinity of Jacksonboro', Screven County, Georgia, near the confluence of Brier Creek and Beaver Dam Creek, was originally discussed by Lyell and referred to the Eocene. In Bulletin 84 of the United States Geological Survey the writer and Mr. Harris, on the basis of material collected by Professor W. B. Clark, referred it to the vicinity of the Chipola and Tampa horizons. The matter was still further complicated by the reception from another source of some of this material, thus stated to be from the white limestone of Claiborne Bluff, Alabama. Several species were described in the early part of this work, as elsewhere noted (p. 1400), under this misapprehension. The locality was again visited by Mr. Vaughan in 1902 and more material obtained, leaving no reasonable doubt that the Jacksonboro' horizon is practically that of the Tampa limestone or Orbitolite bed of Florida.

The following species have been obtained from this locality and are now in the National Museum:

Actæon n. sp.
Bulla petrosa Conrad, also Tampa.
Bulla (etc.), three species.
Pleurotoma sp.
Drillia servata Conrad, also Chipola, etc.
Drillia sp.
Olivella sp.
Marginella sp.
Mitra n. sp.
Cerithium georgianum Lyell and Sowerby, also Tampa.
Cerithium platynema Dall, also Tampa.
Cerithium n. sp., also Tampa.
Pyrazisinus cornutus Heilprin, also Tampa.
Pyrazisinus, two new species.
Strombus albirupianus Dall.
Turritella tampæ Heilprin, also Tampa.
Modulus turbinatus Heilprin, also Tampa.
Scala (Amæa) n. sp.
Calyptræa trochiformis Lamarck, also Tampa.
Calyptræa.
Xenophora conchyliophora Born, also Tampa.
Amalthea sp.
Ampullina streptostoma Heilprin, also Tampa.
Amauropsis ocalana Dall.
Fissuridea sp.
Dentalium mississippiensis Conrad.
Modiolus sp.
Lithophaga nuda Dall, also Tampa.
Mytilus sp.
Pecten n. sp.?.
Cardium virile Dall, var., also Chipola.
Chama Lyelli Dall.
Phacoides, two species.
Tellina merula Dall, also Tampa.
Tellina sp.
Macoma, two species.
Psammosolen sp.
Fistulana ocalana Dall.

Orbitoides n. sp.

Altogether about forty-four species, of which some ten are peculiar to this horizon, while fourteen are common to it and to the Tampa limestone or the silex beds immediately below it. Were all the species critically investigated this portion would probably be largely increased. Most of the other species are as yet undetermined specifically, thus showing that seven-tenths of the determined species are identical with those of the Tampa limestone and silex beds.

THE CHIPOLA BEDS.

Marl containing Chipola fossils was first observed by Langdon at the base of Alum Bluff in 1887. Mr. Burns, who had been sent by the writer to collect from this bed in 1890, fortunately discovered on the Chipola River to the westward outcrops of the same bed much more accessible and with the fossils in much better preservation. At his suggestion the name which they have borne ever since was adopted for these beds. They were noticed in Bulletin 84 of the United States Geological Survey, and after a personal exploration of them by the writer and Mr. J. Stanley Brown, of the United States Geological Survey, in 1893, a more complete account was published in the Bulletin of the Geological Society of America.* To this the reader is referred for stratigraphic details. It should be added that Bailey's Ferry over the Chipola River in 1890 is now succeeded by a good iron bridge built by the county, and the locality may be recognized by this bridge.

Subsequent collections greatly enriched the series of gastropods from the Chipola marl after that portion of this Memoir treating of the gastropods had been issued. The pelecypods have been studied as far as our material would admit, but many of the gastropods still remain undetermined, which will account for the incomplete nomenclature of the gastropod part of the following list. A few of the most remarkable have been figured and named on the plates of the present volume. The fauna comprises three hundred and thirty-three species, to which we may expect additions on further exploration. A species of *Orthaulax* different from that found in St. Domingo or the Tampa Orthaulax bed, a rich development of the genus *Marginella,* a species of the group of *Oliva* called by von Martens *Omogymna,* a species of *Spheniopsis,* heretofore only known from the European Oligocene, these are among the interesting features of the fauna.

The group of species is distinctly subtropical, but less indicative of warm seas than the Bowden marl of Jamaica, with which the Chipola beds have sixteen species in common. Only one species is known to be found both in

* Vol. v., pp. 147–170, 1894. "Old Miocene" is here used for Oligocene.

the Chipola beds and the Oligocene of St. Domingo. About half the species in the Chipola marl are peculiar to it, and of the others the largest percentage is found in the Tampa silex beds, while in the subsequent Oak Grove sands twenty-four per cent. of the Chipola species occur. Thirty-five species survive to the existing fauna.

In 1893 * Dr. A. F. Foerste published some studies on the Chipola Miocene of Bainbridge, Georgia, and Alum Bluff, Florida. These observations, while not discreditable for the time when they were published, in the light of more thorough explorations and studies which have followed them may be termed largely obsolete, and frequently Dr. Foerste's speculations have not proved happy. Their chief importance lies in the observations quoted from others, especially those of Pumpelly, who recognized accurately the residual character of the red clay deposits between Bainbridge and Alum Bluff, which had been hastily included by some writers in the Lafayette, but are largely Oligocene. The proposition, advanced by Dr. Foerste, that the Chipola and the Chesapeake formations were "to a considerable extent contemporaneous," in view of the section at Alum Bluff was not defensible at the time, and no one will regard it as needing further criticism at present.

In the course of this paper Dr. Foerste gives a list of species from a locality near Bainbridge which he calls "Gastropod Gully," but which he does not more precisely locate. On a visit to Bainbridge the collections were found to have been removed and, in the absence of Professor Pumpelly, the locality could not be identified. Applications for an opportunity to examine the specimens made to Dr. Foerste by mail failed to elicit any response, and the real horizon to which his fossils should be referred remains doubtful. It is probable that the majority of them were, as he supposed, of Chipola age, while others may have been residual from superincumbent beds. I have understood from verbal communications of Dr. Brooks and others that most of them were of the nature of silicious pseudomorphs. These fossils should not be confounded with the Chattahoochee fossils discovered by Vaughan at Russell Springs on the Flint River and already referred to, which belong to a much older series of beds.

LIST OF CHIPOLA FOSSILS.

A, lower bed, Alum Bluff; B, one mile below Bailey's Ferry (now the county bridge) over the Chipola River; C, Chipola River at Ten-Mile Creek, and upper bed at McClellan's farm; * also recent. A few forms are added from Miss Maury's list.

* Am. Journ. Sci., xlvi., pp. 245–254, Oct., 1893.

Nautilus sp. (Maury).

Vaginella chipolana Dall, C.
*Cuvierina columnella Rang, C.
Actæon cubensis Gabb, A.
Actæon textilis Guppy, A, B.
Actæon chipolanus Dall, C.
Actæon fusulus Dall, C.
Ringicula semilimata Dall, B, C.
Ringicula chipolana Dall, A.
*Volvula oxytata Bush, C.
Tornatina incisula Dall, A, B, C.
Tornatina persimilis Dall, C.
Tornatina Fischeri Dall, C.
Tornatina sp., C.
Retusa chipolana Dall, C.
*Retusa sulcata Orb., C.
Retusa (Cylichnina) decapitata Dall, C.
Cylichna jacksonensis O. Meyer, A.
Scaphander Langdoni Dall, C.
Atys œdemata Dall, C.
Atys obscurata Dall, A.
Atys (Acrostemma) gracilis Dall, A, C.
Haminea pompholyx Dall, A, C.
*Bulla striata Bruguière, C.
Micromelo (Abderospira) chipolana Dall, C.
Dolabella Aldrichi Dall, A, C.
Terebra (Oxymeris) Langdoni Dall, B, C.
Terebra (Oxymeris) Langdoni var. perpunctata Dall, B.
Terebra (Oxymeris) chipolana Dall, B.
Terebra (Oxymeris) bipartita Sowerby, C.
Terebra (Oxymeris) sulcifera Sowerby, C.
Terebra inæqualis Sowerby, B, C.
Conus chipolanus Dall, C.
Conus isomitratus Dall, A, B, C.
Conus sulculus Dall, B.
Conus demiurgus Dall, A, C.
Conus, two sp., C.
*Pleurotoma albida Perry, B, C.
Pleurotoma servata Conrad, C.
Pleurotoma sp., C.
Pleurotoma (Cordieria) infans O. Meyer, B.
Cythara sp., C.
Drillia (Cymatosyrinx) sp., C.
Drillia sp., C.
Drillia jamaicensis Guppy, A, B.
Drillia squamosa Guppy, B.
Drillia, ten sp., B, C.
Mangilia sp., C.
Cancellaria.
Oliva liodes Dall, C.
Oliva (Omogymna) Martensi Dall, C.
Olivella eutacta Dall, C.
Ancilla chipolana Dall, C.
Marginella aurora Dall, C.
Marginella sp., C.
Persicula sp., C.
Lyria musicina Heilprin, C.
Mitra (Pleioptygma) carolinensis var.? Conrad, C.
Mitra (near) Dohrni Adams, C.
Mitra sp., C.
Conomitra staminea Conrad, C.
Turbinella polygonata Heilprin, A.
Turbinella Wilsoni Conrad, A.
Turbinella chipolana Dall, A, C.
Vasum engonatum Dall, A, C.
Fasciolaria Sparrowi Emmons, C.
Fasciolaria sp., C.
Fasciolaria Ramondi Maury, C.
Mazzalina costata Dall, C.
Latirus sp., C.
Busycon (= Fulgur) spiniger Conrad, C.
Busycon spiniger var. nodulatum Conrad, C.
Busycon spiniger var. Burnsii Dall, C.
Melongena sculpturata Dall, C.
Fusus
Phos (Strongylocera) chipolanus Dall, C.

Nassa sp., C.
Astyris sp., C.
Strombina eugrammata Dall, C.
Strombina sp., C.
Murex mississippiensis Conrad, C.
Murex trophoniformis Heilprin, C.
Murex chipolana Dall, C.
Muricidea spinulosa Heilprin, C.
Muricidea sp., C.
Muricidea (Pseudoneptunea) sp., C.
Typhis obesus Gabb, C.
Typhis linguiferus Dall, C.
Longchæus arenosus Conrad, A, C.
Longchæus sp., C.
Longchæus sp., A.
Callolongchæus sp., C.
Triptychus sp., C.
Turbonilla (Pyrgiscus) chipolana Dall, C.
Turbonilla (Pyrgiscus) sp., C.
Turbonilla (Pyrgiscus), two sp., A.
Turbonilla (Strioturbonilla) sp., A.
Odostomia (Chrysallida) sp., C.
Odostomia (Oscilla) sp., C.
Odostomia (Scalenostoma) sp., A.
Cassis (Phalium) Aldrichi Dall, C.
Cypræa Willcoxi Dall, C.
Cypræa chilona Dall, A.
Orthaulax Gabbi Dall, A, C.
Strombus Aldrichi Dall, B, C.
Strombus chipolanus Dall, C.
*Triforis modesta C. B. Adams, C.
*Triforis melanura C. B. Adams, C.
*Triforis decorata C. B. Adams, C.
Triforis distincta O. Meyer, C.
Triforis terebrata Heilprin, var., C.
Triforis mitella Dall, C.
*Seila Adamsi H. C. Lea, C.
Seila Adamsi var. attenuata Dall, C.
Bittium chipolanum Dall, C.
Bittium chipolanum var. Burnsii Dall, C.
Bittium permutabile Dall, C.
Bittium Cossmanni Dall, C.
Bittium boiplex Dall, C.
Bittium (Alabina) cerithidioide Dall.
Cerithium chipolanum Dall, C.
Cerithium sp., C.
Potamides (Pyrazisinus) sp., C.
Potamides Harrisii Maury, C.
Clava chipolana Dall, C.
Alaba chipolana Dall, C.
Modulus Willcoxi Dall, C.
Turritella indenta Conrad var. mixta Dall, C.
Turritella indenta Conrad, C
Turritella terebriformis Conrad, var., C.
Turritella chipolana Dall, C.
Turritella subgrundifera Dall, C.
*Turritella subannulata var. acropora Dall, C.
Solarium chipolanum Dall, C.
Solarium nuperum Conrad, C.
*Rissoina lævigata C. B. Adams, C.
*Rissoina decussata Montagu, C.
Rissoina chipolana Dall, C.
*Adeorbis supranitidus S. Wood, C.
*Assiminea affinis Orbigny, C.
Crucibulum chipolanum Dall, C.
*Calyptræa centralis Conrad, C.
*Crepidula fornicata Say, C.
*Crepidula plana Say, C.
Xenophora textilina Dall, C.
Natica plicatella Conrad, C.
Natica alticallosa Dall, C, A.
Natica (Cryptonatica) floridana Dall, C.
Polynices (Neverita) chipolanus Dall, A, C.
Polynices (Lunatia) hemicryptus Gabb, C.
Ampullina Fischeri Dall, C.
Amauropsis perovatus Conrad var. ocalana, D, C.
Amauropsis Burnsii Dall, C.
Sigaretus chipolanus Dall, C.

*Eulithidium breve Orbigny, C.
*Phasianella affinis C. B. Adams, C.
Astralium (Lithopoma) chipolanum Dall, A.
Astralium sp., C.
Collonia chipolana Dall, C.
Chlorostoma (Omphalius) exoletum Conrad, A.
Chlorostoma (Omphalius) limatum Dall, A, C.
Calliostoma metrium Dall, C.
Calliostoma grammaticum Dall, A, C.
Calliostoma exile Dall, A.
Solariella turritella Dall, C.
Liotia (Arene) agenea Dall, C.
Teinostoma (Pseudorotella) chipolanum Dall, C.
Teinostoma (Solariorbis) microforatis Dall, C.
Cyclostrema chipolanum Dall, C.
Neritina chipolana Dall, C.
Neritina sp., C.
Lucapinella sp., C.
Fissuridea chipolana Dall, A, C.

Dentalium Danai O. Meyer, A.
*Dentalium disparile Orbigny, A, C.
*Dentalium leptum Bush, C.
*Dentalium filum Sowerby, C.
Cadulus newtonensis Meyer and Aldrich, C.
Cadulus vicksburgensis Meyer, C, A.
Cadulus sp., C.

Nucula chipolana Dall, A, C.
*Leda acuta Conrad, C.
Leda canonica Dall, C.
Leda chipolana Dall, C.
Yoldia frater Dall, C.
Trinacria Meekii Dall, C.
Glycymeris subovata Say, A, C.
*Arca umbonata Lamarck.
Arca paratina Dall, A, C.
Barbatia marylandica Conrad, A, C.
Barbatia phalacra Dall, C.
*Barbatia candida Gmelin, A, C.
*Barbatia reticulata Gmelin, C.
*Barbatia (Fossularca) Adamsi Smith, C.
Scapharca (Cunearca) initiator Dall, C.
Scapharca hypomela Dall, A, C.
Scapharca latidentata Dall, A, C.
Scapharca santarosana Dall, A, C.
Scapharca staminata Dall, C.
Scapharca accompsa Dall, C.
Atrina chipolana Dall, A, C.
Pteria chipolana Dall, A, C.
Ostrea sellæformis Conrad var. rugifera Dall, A, C.
Ostrea compressirostra Say, A.
Pecten Burnsii Dall, C.
Pecten (Nodipecten) condylomatus Dall, C.
Pecten (Lyropecten) Madisonius Say var. Sayanus Dall, C.
Pecten (Æquipecten) chipolanus Dall, A, C.
Pecten (Chlamys) alumensis Dall, A.
Amusium precursor Dall, A, C.
Spondylus chipolanus Dall, A, C.
Plicatula densata Conrad, A, C.
Lima tampaënsis Dall, C.
*Pododesmus rudis Broderip, var.?, C.
Anomia microgrammata Dall, A, C.
Modiolus (Brachydontes) curtulus Dall, A.
*Modiolus (Botula) cinnamomeus Lamarck, C.
Crenella minuscula Dall, A.
Modiolaria (near lateralis), C.
Julia floridana Dall, C.
Verticordia (Trigonulina) Cossmanni Dall, C.

Coraliiophaga elegantula Dall, C.
Crassatellites (Scambula) chipolanus Dall, A, C.
Crassatellites (Crassinella) triangulatus Dall, A, C.
Cardita (Carditamera) tegea Dall, A, C.
Venericardia hadra Dall, A, C.
Venericardia (Pleuromeris) tellia Dall, A, C.
Chama chipolana Dall, A, C.
Chama draconis Dall, C.
Codakia (Jagonia) erosa Dall, C.
Codakia (Jagonia) sp., A, C, also in silex beds.
Codakia (Jagonia) chipolana Dall, A.
Lucina janus Dall, A, C, also Sopchoppy limestone.
Lucina corpulenta Dall, C.
Phacoides (Here) Glenni Dall, A, C.
Phacoides (Cavilucina) recurrens Dall, A, C.
Phacoides (Lucinisca) calhounensis Dall, C.
Phacoides (Miltha) chipolanus Dall, A, C.
Phacoides (Miltha) heracleus Dall, A.
Phacoides (Miltha) hillsboroënsis Heilprin, A, C.
Phacoides (Parvilucina) sphæriolus Dall, A, C.
Divaricella chipolana Dall, A, C.
Diplodonta alta Dall, A, C.
Solecardia (Spaniorinus) sp., C.
Hindsiella nephritica Dall, A.
Erycina undosa Dall, A, C.
Erycina chipolana Dall, A, C.
Alveinus rotundus Dall, C.
Montacuta chipolana Dall, A, C.
Aligena pustulosa Dall, C.
Cardium propeciliare Dall, C.
Cardium acrocome Dall, C.
Cardium (Trachycardium) inconspicuum Dall, C.
Cardium (Trachycardium) sp., A.
Cardium (Trachycardium) cestum Dall, C.
Cardium (Trachycardium) virile Dall, C.
Cardium (Trachycardium) parile Dall, A, C.
?Cardium (Cerastoderma) waltonianum Dall, Walton County.
?Cardium (Cerastoderma) pansatrum Dall, Walton County.
Cardium (Cerastoderma) chipolanum Dall, A, C.
Cardium (Fragum) Burnsii Dall, C.
Cardium (Trigoniocardia) alicula Dall, A, C.
Cardium (Trigoniocardia) Simrothi Dall, C.
Papyridea bulbosa Dall, C.
Lævicardium compressum Dall, C, A.
*Lævicardium serratum Linné, A.
Dosinia (Dosinidia) chipolana Dall, A, C.
Grateloupia alumensis Dall, A.
Transennella utica Dall, A, C.
Transennella chipolana Dall, C.
Gafrarium (Gouldia) erosum Dall, C.
Macrocallista acuminata Dall, A.
*Macrocallista (Chionella) maculata Linné, A, C.
Callocardia (Agriopoma) sincera Dall, A, C.
Pitaria (Hyphantosoma) floridana Dall, A, C.
Pitaria (Lamelliconcha) astartiformis Conrad, A, C.
Cytherea cæsarina Dall, C, also White Beach.
Cytherea (Ventricola) Blandiana, Guppy, C.

Chione chipolana Dall, A, C.
Chione sp., A.
Chione (Lirophora) Burnsii Dall, A, C.
Anomalocardia chipolana Dall, A.
Venus Langdoni Dall, C, A.
Tellina chipolana Dall, A, C.
Tellina strophia Dall, C.
Tellina (Macaliopsis) cloneta Dall, C.
*Tellina (Merisca) æquistriata Say, A.
Tellina (Merisca) hypolispa Dall, A, C.
Tellina (Moerella) acloneta Dall, C.
Tellina (Angulus) pressa Dall, C.
Tellina (Angulus) acosmita Dall, C.
Tellina (Angulus) acalypta Dall, A.
Tellina (Scissula) lampra Dall, A, C.
*Strigilla flexuosa Say, A.
Metis chipolana Dall, A, C.
Macoma calhounensis Dall, C.
Macoma (Psammacoma) tracta Dall, Walton County.
Semele chipolana Dall, A, C.
Semele Smithi Dall, C.
Semele mutica Dall, C.
Semele mutica var. Stearnsii Dall, C.
Semele mutica var. scintillata Dall, C.
Semele (Semelina) cytherioidea Dall, C.
Donax chipolana Dall, C.
Donax chipolana var. curtula Dall, C.
Solen amphistemma Dall, A, C.
Siliqua subequalis Gabb, A, C.
Psammosolen vicksburgensis Aldrich, C.
Mactra chipolana Dall, C.
Ervilia chipolana Dall, A, B.
Ervilia triangularis Dall, C.
Spheniopsis americana Dall, C.
Corbula (Cuneocorbula) Burnsii Dall, A, C.
Corbula (Cuneocorbula) sphenia Dall, C.
Corbula (Cuneocorbula) sarda Dall, A.
Corbula (Cuneocorbula) seminella Dall, A, C.
Corbula (Aloidis) heterogenea Guppy, A, C.
Corbula (Bothrocorbula) synarmostes Dall, C.
Panopea Whitfieldi Dall, C.
Gastrochæna rotunda Dall, C.

THE OLIGOCENE MARL OF BOWDEN, JAMAICA.

The bed of marl which contains the rich fauna of Bowden occurs in a calcareous gravel at the foot of Baker's Hill, Morant Bay, Jamaica, about three feet above the sea. The species described from the "Miocene" of Jamaica by Guppy were collected at this locality by Henry Vendryes, Esq., and the types of Guppy's descriptions now form part of the collections of the United States National Museum. Corals from this locality were described by Duncan,* who referred the formation to the "Miocene" on account of the similarity of the fauna to that of the beds near Bordeaux in France which are now referred to the Oligocene, but which at that time were generally called Miocene. The change of denomination was made years ago in Europe, but the Jamaica fossils continued until lately to carry the erroneous name. In 1896 the writer made

* Quart. Journ. Geol. Soc., London, xix., p. 454. 1863.

the correction * which is now generally accepted. A summary of the long and somewhat complicated history of this formation is given by Hill † with determinations of the foraminifera by Dr. R. M. Bagg, whose geological discrimination has not kept pace with his undoubtedly wide knowledge of the special group to which his studies are devoted, as he still refers the Vicksburg to the Eocene, and does not discriminate it from the nummulitic series, while he concludes that the Bowden foraminiferal fauna must be Miocene. This, from the evidence of the molluscan and corallian fauna is undoubtedly a mistaken conclusion, the explanation of which, perhaps, lies in the suggestion that the species of foraminifera which he limits to the Miocene began their career earlier in the tropics, and reached more northern waters, where the foraminiferal fauna has been more thoroughly studied, a degree later in geological time. Certainly the tropical forms like *Nummulites,* found in the Bowden marl, are unknown in the typical Chesapeake Miocene of Maryland and Virginia.

In the early descriptions of the molluscan fossils of Bowden many species were referred to as identical with recent forms, a natural error, since there are many which are the precursors of living forms and have their general aspect, but which prove on critical study to be specifically distinct. The total number of mollusks collected at Bowden by Henderson and Simpson, together with a few described by Guppy which they did not obtain, amounts to four hundred and thirty-five species, of which twelve per cent. appear to be identical with recent species, while in the Chipola fauna, in which, on the continent, we find the nearest analogue of the Bowden horizon, about 10.5 per cent. are recognized as recent. The Miocene fauna of Duplin, the only one at present which can well be compared with an Antillean fauna, has a little over eighteen per cent. of its species identical with recent forms. The climatic changes which modified the Oak Grove fauna and ushered in the temporary invasion of northern species, which constitute the Alum Bluff Miocene fauna, affected both those faunas in a way which makes them unsuitable for a direct comparison with a continuously evolved marine population which, like that of the Antilles since the Cretaceous, has been wholly sheltered from violent climatic changes.

The most intimate relations of the Bowden fauna are with the somewhat older Oligocene of Haiti and St. Domingo, which is still in great need of stratigraphic elucidation. Gabb and others regarded all the Antillean Oligocene

* Proceedings U. S. Nat. Museum, xix., No. 1110, pp. 303–5, 1896.

† Bull. Mus. Comp. Zoology, xxxiv., pp. 145–152, 1899.

beds as practically of the same age, or so nearly so that the species from different localities, such as Bowden and St. Domingo, might be enumerated in the same list. It is, however, certain that the St. Domingo beds contain a fauna which is older than that of Bowden and bears much the relation to it that the Tampa silex beds do to the Chipola in Florida. Nearly twenty per cent. of the Bowden species are common to the St. Domingo fauna, judging, not from lists, but from material which I have compared from the two sources. With the Tampa silex beds Bowden holds ten species in common, with the Chipola fourteen species. The very characteristic genus *Orthaulax*, which occurs in St. Domingo and in the silex beds and Chipola marl of Florida, is not known from Bowden.

With the Miocene of Florida the Bowden fauna has five species in common, and they are all species which extend from the Oligocene upward, and are still found in the living state, hence not characteristic. From the data thus supplied it is obvious that the relations of Bowden are with the upper Oligocene of the continent.

It is perhaps with the Oak Grove sands, or between the Chipola and the Miocene, that the position of the Bowden fauna would be marked most plausibly against the Tertiary column of Florida formations.

LIST OF OLIGOCENE FOSSILS OF THE BOWDEN FAUNA.

The following species, many of which are still unnamed and are apparently new, were chiefly collected by Messrs. Henderson and Simpson, and Henry Vendryes, Esq., of Jamaica. Others reached the National Museum through Messrs. Bland and Guppy.

Those to which an asterisk is prefixed are supposed to survive to the recent fauna; those to which a D is added are also known from the Oligocene of St. Domingo or Haiti; those followed by C, from the Chipola, and those followed by T, from the silex beds of Tampa, Florida.

LANDSHELLS.

Pleurodonte bowdeniana Simpson.
*Stenogyra sp.
Melaniella sp.
Neocyclotus (Ptychostylis) Bakeri Simpson.
*Truncatella sp.
Lucidella costata Simpson.

MARINE SPECIES.

Cavolinia Vendryesiana Guppy.
Cavolinia digitata Guppy.
Cavolinia ventricosa Guppy.
Cavolinia, near gibbosa Rang.
Cavolinia (Diacria), near trispinosa Lesueur.
Actæon textilis Guppy.
Actæon sp.

Ringicula tridentata Guppy.
Tornatina Wetherilli Lea, T.
*Tornatina canaliculata Say, var.
*Tornatina bullata Kiener.
*Tornatina recta Orbigny.
Tornatina coixlacryma Guppy, D.
Cylichna, near sulcata Orbigny.
Atys obscurata Dall.
Atys sp.
Utriculus sp.
*Volvula cylindrica Gabb, D.
Volvula sp., near caribæa Orbigny.
*Bulla striata Bruguière, D.
Bulla (striata var.?) Vendryesiana Guppy.
Terebra Gabbi Dall, D.
Terebra inæqualis Sowerby, D.
Terebra sulcifera Sowerby, D.
Terebra bipartita Sowerby, D.
Terebra sp., near protexta Conrad.
Terebra sp., near inornata Dall.
Conus planiliratus Sowerby, D.
Conus stenostomus Sowerby, D.
Conus consobrinus Sowerby, D.
Conus domingensis Sowerby, D.
Conus haitensis Sowerby, D.
Conus granozonatus Guppy, D.
Conus recognitus Guppy, D.
Conus interstinctus Guppy, D.
Conus gracilissimus Guppy, D.
Conus, five species.
*Pleurotoma albida Perry, D.
Pleurotoma Barretti Guppy.
Pleurotoma consors Sowerby, D.
Pleurotoma Henekeri Sowerby, D.
Pleurotoma (Drillia) venusta Sowerby, D.
Pleurotoma (Drillia) jamaicensis Guppy.
*Pleurotoma (Drillia) ostrearum Stearns.
Pleurotoma (Drillia) Newmani Dall, T.
Pleurotoma (Drillia) haitensis Guppy, D.
Pleurotoma (Drillia), five species.
Pleurotoma (Cymatosyrinx), five species.
Pleurotoma (Ancistrosyrinx) miranda Guppy, D.
Cythara mucronata Guppy.
Cythara obtusa Guppy.
Cythara elongata Gabb.
Cythara Guppyi Dall.
Cythara gibba Guppy.
Cythara, three sp.
Clathurella amicta Guppy.
Clathurella Vendryesiana Dall.
Clathurella, two sp.
Glyphostoma, two sp.
Mangilia consentanea Guppy.
Mangilia, six sp.
Cancellaria lævescens Guppy, D.
Cancellaria Moorei Guppy, D.
Cancellaria Barretti Guppy, D.
Cancellaria (Trigonostoma) scalatella Guppy.
Cancellaria (Trigonostoma) sp.
Oliva cylindrica Sowerby, D.
Oliva, near reticularis Lam.
Oliva magna Dall.
Oliva, near masaris Duclos.
Oliva plicata Guppy.
Olivella indivisa Guppy.
*Olivella rotunda Dall, var.
Olivella, near mutica Say.
Olivella, near jaspidea Gmelin.
Ancilla pinguis Guppy.
Marginella coniformis Sowerby, D.
Marginella, two sp.
Persicula sp.
Mitra Henekeri Sowerby, D.
*Mitra styria Dall.
Mitra, six sp.
Mitromorpha sp.
Perplicaria sp.
Turbinella textilis Guppy.
Fasciolaria semistriata Sowerby, D.
Fasciolaria intermedia Sowerby, D.

*Latirus infundibulum Gmelin.
Latirus sp.
Melongena consors Sowerby, D.
Fusus Henekeri Sowerby, D.
Phos Moorei Guppy, D.
Phos Gabbi Dall, D.
Phos elegans Guppy, D.
Strongylocera Guppyi Gabb, D.
Strongylocera solidulus Guppy.
Metula cancellata Gabb, D.
Nassarina sp.
*Nassa ambigua Montagu, D.
Nassa, near consensa Ravenel.
Nassa, near bidentata Emmons.
Strombina ambigua Guppy.
Strombina gradata Guppy.
Columbella sp.
Anachis haitensis Sowerby, D.
Anachis sp.
Astyris caribæa Gabb, D.
Astyris sp.
Nitidella, near cribraria Lamarck.
Murex domingensis Sowerby, D.
*Murex (Phyllonotus) pomum Gmelin, var.
Muricidea collata Guppy.
Typhis obesus Gabb, D.
Typhis sp.
Typhis alatus Sowerby, D.
Coralliophila miocenica Guppy.
Scala (Amæa) Leroyi Guppy.
Scala (Acrilla) sp., near retifera Dall.
Scala, near lineata Say.
Scala, four sp.
Opalia sp.
Aclis acuminata Guppy.
Aclis (Amblyspira) prominens Guppy.
Liostraca nobilis Guppy.
Liostraca sp.
Eulima sp.
Niso grandis Gabb, D.
Longchæus forulatus Guppy.
Callolongchæus jamaicensis Dall, also Gatun?.
Triptychus indiscretus Guppy.
Eulimella tenuilineata Guppy.
Turbonilla (Chemnitzia) sp.
Turbonilla (Pyrgiscus) turritissimus Guppy.
Turbonilla (Pyrgiscus), three sp.
Turbonilla (Strioturbonilla) sp., also Trinidad.
Turbonilla (Strioturbonilla) sp.
Turbonilla (Lancea), two sp.
Turbonilla (Pyrgiscus) angulata Guppy.
Odostomia (Scalenostoma) sp.
Odostomia (Odostomia) sp.
Distortrix simillima Sowerby, D.
*Gyrineum crassum Dillwyn.
Lampusia, three sp.
Colubraria sp., near lanceolata Menke.
Cassis sulcifera Sowerby, D.
Cassis reclusa Guppy.
Cassis monilifera Guppy.
Sconsia sublævigata Guppy.
Sconsia, near striata Lamarck.
Malea camura Guppy, D.
Pyrula carbasea Guppy, D.
Ovula (Simnia) immunita Guppy.
Ovula (Simnia) sp.
Cypræa, near spurca Linné.
Cypræa, near flaveola Lamarck.
*Trivia suffusa Gray.
*Trivia pediculus Linné.
*Trivia globosa Gray.
*Erato Maugeriæ Gray.
Strombus haitensis Sowerby, D.
Strombus ambiguus Sowerby, D.
Strombus bifrons Sowerby, D.
Strombus pugiloides Guppy, D.
Triforis, two sp.
Clava plebeia Sowerby, D.
Clava sp.
*Cerithium algicola C. B. Adams.

Cerithium, near floridanum Mörch.
Cerithium, four sp.
*Bittium (Alabina) cerithidioide Dall.
Bittium (Alabina) præformatum Guppy.
Bittium, three sp.
Planaxis sp., near nucleus Wood.
Modulus modulus L., var. basileus Guppy.
Modulus, near floridanus Conrad.
Crepitacella cepula Guppy, D.
Serpulorbis papulosus Guppy.
Vermicularia, near spirata Philippi.
Petaloconchus domingensis Sowerby, D.
Turritella tornata Guppy, D.
Mathilda plexita Dall.
Mathilda sp.
Fossarus (Gottoina) mundulus Guppy.
Fossarus sp.
Isapis sp.
Alaba turrita Guppy.
Solarium quadriseriatum Sowerby, D.
Solarium, two sp.
?Separatista sp.
Rissoa, near Lantzii Velain.
*Rissoina Browniana Orbigny.
*Rissoina Sagriana Orbigny.
*Rissoina elegantissima Orbigny.
*Rissoina striaticostata Orbigny.
Rissoina, four sp.
Adeorbis Beaui Fischer var. bicarinata Guppy.
Adeorbis, near sincera Dall.
?Choristes sp.
*Cheilea equestris Linné.
*Crepidula plana Say.
Capulus sp.
Amalthea tortilis Guppy.
*Amalthea subrufa Carpenter.
Xenophora dilecta Guppy.
Natica, near canrena Linné.
Natica alticallosa Dall, C.
*Natica (Stigmaulax) sulcata Born., D.
Natica (Cryptonatica) sp.
Polynices subclausa Sowerby, D.
Neverita sp.
Ampullina Guppyi Gabb, D.
Eunaticina regia Guppy.
Eunaticina, near semisulcata Gray.
Sigaretus, near maculatus Say.
Sigaretus, near minor Dall.
?*Acmæa, two sp.
Cocculina, two sp.
*Phasianella umbilicata Orbigny.
Phasianella sp.
Eulithidium, near breve Orbigny.
Turbo, near filosus Fischer.
Turbo, near crenulatus Gmelin.
Omphalius, near fasciatus Born.
*Microgaza rotella Dall.
*Microgaza rotella var. inornata Dall.
Solariorbis clypeatus Guppy.
Teinostoma sp.
Vitrinella (Episcynia) sp.
Calliostoma decipiens Guppy, D.
*Calliostoma pulcher C. B. Adams.
*Calliostoma asperimum Dall.
*Calliostoma roseolum Dall.
*Calliostoma corbis Dall.
Calliostoma decussatum Gloyne.
Calliostoma sp.
Solariella altiuscula Guppy.
Solariella sp.
Basilissa (Ancistrobasis), near costulata Watson.
Liotia siderea Guppy.
Liotia verisimilis Guppy.
Liotia, two sp.
Neritina Woodwardi Guppy.
Neritina sp.
Neritina (Smaragdia), near viridis Lamarck.
Rimula sp.
Fissuridea, two sp.

Fissurellidea, near limatula Reeve.
Lucapinella, near callomarginata Carpenter.

Dentalium dissimile Guppy.
Dentalium haitensis Gabb, D.
*Dentalium Gouldii Dall?.
Dentalium ponderosum Gabb, D.
Dentalium macilentum Pilsbry.
Dentalium Schumoi Pilsbry.
Cadulus dentalinus Guppy.
Cadulus depressicollis Pilsbry and Sharp.
Cadulus annulatus Pilsbry.
Cadulus Simrothi Pilsbry.

Leda indigena Dall.
Leda clara Guppy.
Leda illecta Guppy.
Leda Packeri Forbes.
Leda peltella Dall.
Leda Guppyi Dall.
Leda perlepida Guppy.
Yoldia nasuta Gabb, D.
Yoldia ovalis Gabb, D.
Yoldia Crosbyana Guppy.
Glycymeris subovata Say, C.
Glycymeris jamaicensis Dall.
*Arca occidentalis Philippi.
Arca bowdeniana Dall.
*Barbatia candida Gmelin, C.
*Barbatia reticulata Gmelin, C.
*Barbatia Adamsi Smith, C.
Barbatia ovalina Dall.
Scapharca halidonata Dall.
Scapharca inæquilateralis Guppy.
Scapharca donacia Dall.
*Scapharca auriculata Lamarck.
Scapharca (Argina) tolepia Dall, D.
Scapharca (Bathyarca) Hendersoni Dall.
Ostrea haitensis Sowerby, D.
*Ostrea megodon Hanley, D.
Pecten soror Gabb, D.
Pecten (Euvola) bowdenensis Dall.
Pecten (Æquipecten) oxygonum Sowerby, D.
Pecten (Æquipecten) inæqualis Sowerby, D.
Pecten (Æquipecten) thetidis Sowerby, D.
Pecten (Chlamys) vaginulus Dall.
Pecten (Pseudamusium) Guppyi Dall.
*Amusium papyraceum Gabb, D.
Amusium Lyoni Gabb.
Spondylus bostrychites Guppy.
Plicatula densata Conrad, T, C.
*?Plicatula gibbosa Lamarck.
Limæa solida Dall.
Placunanomia lithobleta Dall.
Anomia indecisa Guppy.
Modiolus Guppyi Dall.
*Crenella divaricata Orbigny, D.
Verticordia bowdenensis Dall.
Verticordia (Haliris) jamaicensis Dall.
Poromya jamaicensis Dall.
Cuspidaria (Cardiomya) craspedonia Dall.
Cuspidaria (Bowdenia) distira Dall.
Crassatellites jamaicensis Dall.
Crassinella Guppyi Dall.
Crassinella bowdenensis Dall.
Chama involuta Guppy.
Echinochama antiquata Dall, D.
Venericardia scabricostata Guppy, D.
Pteromeris acaris Dall.
Codakia spinulosa Dall.
Codakia (Jagonia) pertenera Dall.
Codakia (Jagonia) textilis Guppy.
Codakia (Jagonia) Vendryesi Dall.
Myrtæa limoniana Dall.
Myrtæa (Eulopia) furcata Dall.
Myrtæa (Eulopia) vermiculata Dall, T.
Phacoides domingensis Dall, D, T.
Phacoides (Here) podagrinus Dall.
Phacoides (Here) tithonis Dall.

Phacoides (Pleurolucina) quadricostatus Dall.
Phacoides (Cavilucina) recurrens Dall, C, T.
Phacoides (Callucina) pauperatus Guppy.
Phacoides (Parvilucina) yaquensis Gabb, D.
Phacoides (Bellucina) actinus Dall.
Divaricella prevaricata Guppy.
Diplodonta cupuloides Guppy.
Diplodonta Gabbi Dall.
Diplodonta minor Dall.
*Diplodonta puncturella Dall.
Anisodonta (Basterotia) bowdeniana Dall.
Cardium lingua-leonis Guppy, D.
Cardium inconspicuum Guppy, C.
Cardium, near marmoreum Lamarck.
Cardium (Trachycardium) sp.
Cardium bowdenense Dall, T.
Cardium (Fragum) sp.
*Lævicardium serratum Linné.
*Lævicardium sybariticum Dall.
Protocardia jamaicensis Dall.
Tivela jamaicensis Dall.
*Gouldia insularis Dall.
Callocardia sp. ind.
Pitaria carbasea Guppy.
Pitaria planivieta Guppy.
Cytherea (Ventricola) Blandiana Guppy, C.
Chione Walli Guppy.
Chione Woodwardi Guppy, D.
Lirophora Hendersoni Dall, D.
Anomalocardia bowdeniana Dall.
Tellina acrocosmia Dall.
Tellina sclera Dall.
Tellina lepidota Dall.
Tellina (Eurytellina) sp.
Moerella Simpsoni Dall.
Moerella Hendersoni Dall.
Angulus pharcida Dall.
Angulus pressa Dall, C.
Scissula scitula Dall, D.
Strigilla pisiformis Linné.
Psammacoma tracta Dall, C.
Psammacoma olivella Dall.
Cymatoica Vendryesi Dall.
Abra triangulata Dall.
Donax æqualis Gabb.
Psammosolen vicksburgensis Aldrich, C.
Corbula sericea Dall.
Corbula heterogenea Guppy, C.
Bothrocorbula viminea Guppy, D.
Gastrochæna rotunda Dall, C, T.
Teredina bowdeniana Dall.
Xylophaga sp. ind.
Pholas? sphæroidalis Guppy.
Teredo incrassata Gabb.

Mr. Guppy cites the following from Bowden:

Cupularia Oweni Lamarck.
Membranipora Savarti Audouin.
Orbitoides fortisi D'Archiac.

I add:

Orbitolites (floridanus Conrad =) complanatus Lamarck, collected by Henderson and Simpson.

The following species of foraminifera were identified by Dr. R. M. Bagg for Professor R. T. Hill from material collected at Bowden:

Haplostiche Soldanii P. and J.
Textularia Barrettii J. and P.
Textularia trochus Orb.
Orbiculina adunca F. and M.
Orbiculina compressa Orb.
Cristellaria cultrata Montf.
Cristellaria cassis F. and M.
Cristellaria calcar L.
Gypsina globulus Reuss.
Gypsina vesicularis P. and J.
Cuneolina pavonia Orb.
Cuneolina sp. nov?.
Vaginulina legumen L.
Nummulites Ramondi d'Arch.
Amphistegina Lessonii Orb.

THE OAK GROVE SANDS.

At the village of Oak Grove, Santa Rosa County, Florida, Mr. L. C. Johnson discovered a sandy stratum containing fossils, some of which were submitted to the writer by Professor E. A. Smith. Subsequent exploration by Mr. Frank Burns, of the United States Geological Survey, resulted in procuring a fairly good representation of the fauna of these beds. The fossils are well preserved as regards their form, but are very soft and require hardening before they can be transported. This is done by dipping them repeatedly into a very dilute solution of white shellac in alcohol, which is absorbed and dries in a few moments without leaving any perceptible coating on the outside of the specimens.

The presence of a peculiar *Turritella* (*T. alcida* Dall) in both the Alum Bluff sands and those of Oak Grove, together with *Ostrea trigonalis, Pecten Sayanus,* and a *Pododesmus,* led to the belief that the two may be referred to a single horizon. If this is not the case, they must at least be very nearly of the same age. The deposit at Rock Bluff, with which that at Alum Bluff is apparently continuous, is an oyster-bed, on which only a few species could be expected; that at Oak Grove is an ordinary sea-bottom deposit. The grayish or greenish tint of the sand contrasts strongly with the yellowish tinge of the Chattahoochee or Chipola horizons, and points the way transitionally to the Miocene marls above, in which a grayish color is almost constant.

The influence of the conditions which brought on the Miocene is further shown by the appearance in the fauna of a large *Lyropecten* and other analogous species.

The Burns collection of Oak Grove fossils came to hand after Parts I. and II. were practically completed, and so in the text of this Memoir a complete account of the gastropod fauna has not been given, though the pelecypods were taken in hand with the others. In the following list, however, it has been attempted to include all the species, at least so far as to give their generic names

when the species appear to be undescribed and the whole name when it has been practicable to identify it. In this way the census of the fauna is more comparable with those of adjacent beds above or below.

The relation of this fauna to the Chipola is marked, nearly one-third of the species being identical; and there is also a fair number of species common to Oak Grove, the Tampa silex beds, and Bowden; but with the immediately succeeding Alum Bluff Miocene the proportion drops sharply to less than one per cent. This sharp change is accompanied by a diminution in the number of species constituting the fauna, in harmony with the theory of a diminished temperature. The exiled fauna, however, regained its lost ground to some extent later on, and pushed a representation of its species as far north as the southern part of New Jersey and to a more marked extent to the Carolinas, where we see that the fauna of the upper or Duplin Miocene, even at the distance of more than five hundred miles to the northward, is more intimately related to the Oak Grove fauna than Oak Grove is to the Alum Bluff Miocene deposited with continuous sedimentation on the same spot.

LIST OF SPECIES FROM THE OAK GROVE SANDS.

The great majority of these species come from the typical locality at Oak Grove, Santa Rosa County, Florida, on the Yellow River about six miles south of the Alabama State line. A few have been added from the greenish clayey marl at Rock Bluff, a few miles above Alum Bluff, which is believed to be of the same age as the Oak Grove bed. A letter following the authority for the name indicates that the species is also known from Bowden (B), the Tampa silex bed (S), or the Chipola marl (C). Two or three species are also cited from a depth of about fifteen hundred feet in the Bascom well, near Mobile, Alabama (M), and a few others from the White Beach Oligocene, near Osprey, Florida.

The gastropods of this list, having been received too late to be included in the body of the text, are only approximately identified, but for the most part seem specifically distinct from the analogous species in the Chipola marl.

Vaginella sp. (not the Chipola sp.).
Actæon sp. (cf. cubensis Gabb).
Actæon sp.
Ringicula semilimata Dall, C.
Tornatina incisula Dall, C.
Tornatina persimilis Dall, C.
Tornatina crassiplica Dall n. sp.
Tornatina (Coleophysis) chipolana Dall, C.
*Cylichnella bidentata Orbigny?.
Retusa (cf. sulcata Orbigny).
Retusa (Cylichnina) quercinensis Dall.
Volvula (cf. acuta Orbigny).
Atys sp.
Terebra (cf. indenta Conrad, Duplin).
Terebra psilis Dall.
Terebra tantula Conrad, S.

Terebra Langdoni Dall, C.
Terebra sp., near protexta Conrad.
Conus isomitratus Dall, C.
Conus chipolanus Dall, C.
Conus sp.
*Pleurotoma albida Perry, B, S, also Vicksburgian and recent.
Pleurotoma boadicea Dall.
Drillia Newmani Dall, S.
Drillia sp., near limatula Conrad.
Drillia sp., near jamaicensis Guppy, B.
Drillia sp., near squamosa Guppy.
Drillia, two sp.
Mangilia, near cerina Kurtz and Stimpson.
Mangilia, six sp.
Clathurella sp.
Cancellaria, near Moorei Guppy.
Cancellaria (Trigonostoma) bifoliata Aldrich.
Oliva, near reticularis Lamarck, B.
Oliva cylindrica Sowerby, B.
Olivella, near mutica Say, C.
Marginella (Persicula), three sp.
Marginella, two sp., C.
Marginella, near Jewetti Carpenter.
Marginella, near aureocincta Stearns.
Lyria pulchella Sowerby, S.
Turbinella chipolana Dall, C.
Mitra (cf. mississippiensis Conrad).
Mitra (Turricula) (cf. Hanleyi Dohrn).
Mitra sp.
Busycon stellatum Dall, S.
Busycon radix Dall n. sp.
Busycon, near coronatum Conrad.
Busycon (cf. spiniger Conrad), C.
Fasciolaria? (cf. Sparrowi Emmons) (fragment).
Latirus sp., C.
Nassarina sp.
Nassa, near chipolana Dall.
Nassa, three sp.
Strombina tetrica Dall, C.
Astyris sp., C.
Astyris perfervida Dall.
Astyris sp.
Pterorhytis sp.
Murex sp., near chipolanus Dall.
Urosalpinx sp.
Muricidea sp.
Typhis linguiferus Dall, C.
Coralliophila (cf. magna Dall), S.
Eulima, two sp.
Niso, near Chipola sp.
Pyramidella (Longchæus) arenosa Conrad, C.
Pyramidella (Sulcorimella) sp.
Pyramidella (Eulimella) sp.
Turbonilla (Pyrgiscus), two sp.
Turbonilla (Chemnitzia) sp.
Turbonilla (Strioturbonilla), two sp.
Cypræa sp., near pinguis Conrad.
Strombus chipolanus Dall, C.
Triforis (cf. modesta C. B. Adams).
Seila attenuata Dall, C.
Cerithiopsis sp.
Cerithium sp.
Bittium chipolanum Dall, var., C.
Bittium (cf. boiplex Dall), C.
Bittium sp.
Cæcum sp.
Petaloconchus sculpturatus H. C. Lea, var.
Vermicularia sp.
Bivonia, two sp.
Serpulorbis sp.
Turritella subgrundifera Dall, C.
Turritella alcida Dall, also Rock Bluff.
Isapis anomala Adams, var. caloosaënsis Dall, also Duplin.
Alaba sp., near chipolana Dall.
Litiopa sp., near bombyx Kiener.

Solarium amphitermum Dall.
Solarium chipolanum Dall, C.
Solarium sp.
Rissoa sp.
*Adeorbis supranitidus Wood, var.
Adeorbis, near Beaui Fischer.
*Adeorbis liratus Verrill?.
Adeorbis minuta Aldrich.
Cheila dryas Dall n. sp.
Calyptræa centralis Conrad, var.? C, also Duplin.
Calyptræa sp.
Crucibulum chipolanum Dall, C.
Crucibulum constrictum Conrad? S.
Crucibulum sp. (cf. imbricatum Sowerby).
Crepidula, near plana Say, C, B.
Crepidula, near plana Say.
Crepidula, near æsop Dall.
Natica, near plicatella Conrad.
Natica, near alticallosa Dall, C, B.
Neverita, near percallosa Conrad.
Lunatia hemicrypta Gabb, var.? S, C, also Shiloh.
Lunatia sp.
Eunaticina caractacus Dall.
Ampullina Fischeri Dall, C.
Amauropsis var. floridanus Dall, S.
Sigaretus chipolanus Dall, C, S.
Sigaretus, near multiplicatus Dall.
Sigaretus sp.
*Phasianella affinis C. B. Adams, C.
*Eulithidium breve Orbigny, C.
Chlorostoma exoletum Conrad, S, B, also Duplin.
Chlorostoma (cf. limatum Dall), C.
Calliostoma (Leiotrochus), two sp.
Solariorbis microforatis Dall, C.
Cochliolepis sp.
Episcynia Stimpsoni Dall n. sp.
Neritina sp. (cf. chipolana Dall), C.
Fissuridea chipolana Dall, C.
Dentalium, two sp., C.
Cadulus vicksburgensis Conrad, C, B, also Vicksburg.

Nucula sinaria Dall, M.
*Leda acuta Conrad, C.
Leda dodona Dall.
Yoldia frater Dall, C.
Trinacria Meeki Dall, C.
Glycymeris subovata Say, B, C, N.
*Arca umbonata Lamarck, C, S.
Barbatia phalacra Dall, C.
*Fossularca Adamsi Smith, B, C.
Scapharca latidentata Dall, B, C.
Scapharca dodona Dall.
Scapharca santarosana Dall, B, C.
Atrina chipolana Dall, C.
Ostrea sellæformis Conrad var. panciplicata Dall.
Ostrea trigonalis Conrad, W, Rock Bluff.
Ostrea haitensis Sowerby, B, C.
Lyropecten Sayanus Dall, Rock Bluff.
Pseudamusium Guppyi Dall, B.
Spondylus chipolanus Dall.
Plicatula densata Conrad, C, B, S.
Lima carolinensis Dall.
Pododesmus scopelus Dall, Rock Bluff.
Anomia floridana Dall.
Modiolus sp.
Astarte Wagneri Dall.
Crassatellites densus Dall.
Crassinella tanica Dall.
Pandora (Kennerleyia) dodona Dall.
Chama chipolana Dall, S, C.
Venericardia himerta Dall.
Pleuromeris scitula Dall.
Codakia (Jagonia) chipolana Dall, C.
Lucina santarosana Dall.
Phacoides sp.
Phacoides densatus Conrad.

Phacoides var. Whitfieldi Dall.
Phacoides plesiolophus Dall.
Phacoides piluliformis Dall, M.
Divaricella chipolana Dall, C, B.
Diplodonta alta Dall, C, S.
Diplodonta radiata Dall.
Diplodonta nucleiformis Wagner.
Sportella obolus Dall.
Sportella unicarinata Dall.
Sportella lubrica Dall.
Sportella lioconcha Dall.
Sportella Whitfieldi Dall.
Erycina fabulina Dall.
Erycina curtidens Dall.
Bornia dodona Dall.
Bornia floridana Dall.
Montacuta actinophora Dall.
Aligena pustulosa Dall, C.
Aligena lineata Dall.
Cardium ctenolium Dall.
Cardium delphicum Dall, S.
Cardium malacum Dall.
Cardium pansatrum Dall.
Cardium druidicum Dall.
Cardium taphrium Dall, S?.
Cardium apateticum Dall, M.
Lævicardium compressum Dall.
Dosinia liogona Dall.
Clementia Grayi Dall.
Transennella santarosana Dall.
Gouldia alta Dall.
*Macrocallista maculata Linné, C.
Callocardia Sayana Conrad.
Lirophora glyptocyma Dall.
Chamelea rhodia Dall, S.
Tellina hypolispa Dall, C.
Tellina dodona Dall.
Tellina roburina Dall.
Tellina nucinella Dall.
Angulus agria Dall.
Angulus acalypta Dall, C.
Macoma lenis Dall.
Semele chipolana Dall, C.
Semele var. compacta Dall.
Semelina striulata Dall.
Solen amphistemma Dall.
Mactra cymata Dall.
Spisula dodona Dall.
Spisula densa Dall.
Ervilia planata Dall.
Corbula Whitfieldi Dall, M.
Corbula heterogenea Guppy, C, B.
Bothrocorbula radiatula Dall.
Bothrocorbula var. tenella Dall.
Panopea Whitfieldi Dall, C, S.
Gastrochæna ligula H. C. Lea.

THE MIOCENE FAUNA OF SOUTHERN NEW JERSEY, ESPECIALLY THE MARLS OF SHILOH.

These marls contain a fauna which has been enumerated by Heilprin and monographed by Whitfield. The present writer sent Mr. Frank Burns to make an exhaustive collection at the different exposures, and later himself visited the deposits at Shiloh for stratigraphical study. A summary of the observations made on this occasion, with sections, is contained in Bulletin 84, United States Geological Survey, pp. 39–42. The most important observation made on this occasion was that the surface and upper portion of the "shell marl" from which the fossils were obtained is very irregularly hummocky, with lower

channels between the hummocks which, together with the worn aspect of most of the fossils contained in it, led to the conclusion that the upper portion, if not the whole, of this deposit had been subjected to the action of strong currents (such as affect the present sea-bottom off Cape Hatteras) with the result of mechanically mixing up the fossils, so that the earlier and later deposits are now found irregularly distributed through the marl without regard to age. From this it follows that comparisons based on the total organic contents of the unconsolidated marl are liable to be misleading.

A careful study of the fossils which had been loaned to Professor Whitfield for use in the preparation of his monograph, and returned by him with identifications, confirmed the view above mentioned.

There are about one hundred species known from the Shiloh marls, of which thirteen per cent. are known in the recent state and forty per cent. are peculiar to these marls. The Chesapeake Miocene of Maryland and Virginia has fifty per cent. of the Shiloh species in common with New Jersey. But the upper or Duplin Miocene of the Carolinas has only eight species in common with Shiloh. Mixed with the typical Chesapeake fossils at Shiloh we find only two of the Alum Bluff species, *Sportella Whitfieldi* and *Panopea Whitfieldi.* These might perhaps have been expected, or even a larger number, but there is a certain number of species which are unexpected and belong properly to other horizons, such as the Vicksburgian *Cardium eversum,* the Oligocene *Fasciolina Woodii, Mytiloconcha incurva,* and *Lunatia hemicrypta.* Five of these species are known from Chipola, one from St. Domingo, five from the Tampa silex beds, and two from Vicksburg.

The Shiloh marls occur in patches of limited distribution, and I regard their fauna as containing ten or twelve per cent. of species which normally should not be present in it, and which have come there by mechanical intermixture. These species, however, testify to the presence in this vicinity of a contingent from the Oligocene faunas of the south, the sediments of which in New Jersey were removed by denudation or exist only off the coast beneath the sea.

I have included in my general table the statistics of the Shiloh fauna, the list of which can be found in Professor Whitfield's monograph of the Mollusca and Crustacea of the Miocene formations of New Jersey.

* Monographs of the U. S. Geological Survey, xxiv., 1894; issued in 1895.

THE FLORIDIAN MIOCENE.

After the elimination of the Oligocene series from the so-called Miocene of Florida we have remaining practically only one series of beds which has been identified over a considerable area of northern Florida. The Miocene appears as a soft limestone rock in the vicinity of Jacksonville, and has been traced by material from artesian wells on the east side of the peninsula as far south as Lake Worth. The layers of fossiliferous marl in the vicinity of the Chipola River, at Alum Bluff, and other localities in Western Florida are usually less than thirty feet in thickness, but counting unfossiliferous clays, etc., it has been estimated that the rocks of this age in Florida may have attained to a thickness of some five hundred feet or less. The localities where it has been noticed and the knowledge of the distribution of this series of beds are summarized in Bulletin 84 of the United States Geological Survey, pp. 124–7, 1892. Later and fuller information in regard to the beds in northwest Florida will be found in the Bulletin of the Geological Society of America, v., pp. 147–170, 1894. The Miocene as regarded in the present Memoir was discriminated by the writer from the Oligocene with which it had up to that time been erroneously united in the " Proceedings of the United States National Museum," xix., No. 1110, pp. 303–4, 1896, and in a " Table of North American Tertiary Horizons" in the " Eighteenth Annual Report of the United States Geological Survey," pp. 323–348, a paper handed in for publication in 1895 but not printed until 1898. Long previously, however, the writer had pointed out the important characters which separated these two groups and designated them as Old or subtropical, and Newer or cold-water Miocene. Marine deposits of the latter or true Miocene age have not been shown to exist anywhere in the Antillean region south of Lake Worth, Florida.

As I have on various occasions insisted, the faunal gap between the uppermost Oligocene (Oak Grove) and the Chesapeake or Miocene is the most sudden, emphatic, and distinct in the whole post-Cretaceous history of our southeastern Tertiary, and indicates physical changes in the surrounding region, if not in Florida itself, sufficient to alter the course of ocean currents and wholly change the temperature of the waters on our southern coast.

Some indications of the approaching change are seen in the Oak Grove fauna, but, while that is united by thirty-four per cent. of its species with the fauna of the antecedent Chipola beds, its contribution to the fauna of the succeeding Chesapeake is three species, and these of a kind which recalls the inflexible organization of the goose cited by Darwin. Practically the conditions amount to a complete change of fauna as well as of the character of the fauna.

In Middle America, and to some extent in the Antilles, this epoch was one of profound physical changes. The two continents were united and have never since been effectively separated. The marine Oligocene strata in Costa Rica, according to Gabb, were elevated several thousand feet.

The general movement in elevation spread more slowly to the north and east. That no marine Chesapeake deposits have been found in the Antilles is to be explained by the suggestion that they too were undergoing elevation at the time, accompanied, as on the mainland, with more or less active volcanic phenomena. That the Florida fauna was not exterminated is evident, for in the succeeding Pliocene a number of the Oligocene exiles reappear, and in some parts of the Antilles they must have continuously existed in the meantime.

The Suwannee Strait * between the Floridian islands and the Georgian mainland remained open some time longer, while the Jacksonville limestone and the Chesapeake beds of northern Florida were laid down. Before the end of the Miocene, however, this region also submitted to elevation, the Strait was closed, and the Floridian peninsula and probably the entire Floridian plateau were raised above the sea. Later, in the Pliocene, a slight subsidence, and perhaps a slight westward tilting of the peninsula, took place, accompanied by an increase of sea temperatures. The Pleistocene, though far from glacial as at the north, was a period of diminished sea temperatures and moderate elevation without perceptible tilting. The present epoch has witnessed a slight increase in sea temperatures and a very slight, probably continuous, elevation of the peninsula amounting in all to only a few feet. These changes took place without marked catastrophic changes or dislocation of the strata, while only a few miles away, in the island of Cuba, orogenic changes of great magnitude, attended with more or less violence, are believed to have occurred. All the circumstances point to a discontinuity between the action of geologic forces in the Antilles and that of the Floridian region, and this appears to have been the rule since Mesozoic times.

Another feature upon which emphasis should be laid, and which has hardly received the attention it deserves, is the fact that through a large part of the Floridian region the action of meteorological forces on the rocks of Florida has been exercised in the direction of solution rather than denudation. The character of the rocks, so porous, soft, and soluble, is especially adapted to waste through the percolation of water charged, through the decay of the abundant

* Named by the writer in 1892, and subsequently called by Foerste the Okeefinokee Strait.

tropical vegetation, with carbon dioxide. Hence, the absence of erosion and denudation in the ordinary sense, and the reduction of beds of marl and limestone, in one case two hundred feet or more in thickness, to a relatively thin stratum of residual silicious gravel. Throughout the history of the peninsula the *débris* of one formation has formed the basis of another to a greater or less extent, and the fundamental source of the whole has been the marine organic sediments of the Peninsular limestone, carrying also organic silica and more or less clay dust and oxide of manganese, derived from the sea. Since the Glacial period the coastwise drift due to prevailing winds has added much silica, chiefly in the form of beach sand, and the pumice of the West Indian volcanoes drifted by ocean currents has added no insignificant contribution of mineral matter to the shores. The action of coral reefs and accumulated sediments near the southern margin of the peninsula, as described by Louis Agassiz, has had some effect in enlarging the area of land, but much less than was at first supposed.

LIST OF SPECIES OF THE FLORIDIAN MIOCENE.

The beds of true Miocene in Florida are so very uniform that practically only one phase is presented and the fauna can be considered as from a single horizon. The localities from which the species have been obtained are indicated by letters following the name for the several localities as follows. A, upper bed at Alum Bluff and adjacent outcrops; J, Jackson Bluff southeast of Tallahassee; D, De Leon Springs; K, vicinity of Jacksonville; L, Long Key; C, Coe's Mill; F, artesian well at Fort Worth; W, Walton County, Florida.

The asterisk indicates that the species is believed to survive to the recent fauna.

*Tornatina canaliculata Say, A.
*Terebra protexta Conrad, A.
Conus adversarius Conrad, A.
Drillia (Cymatosyrinx) lunata H. C. Lea, A.
*Drillia ostrearum Stearns, A.
*Drillia æpynota var. acila Dall, A.
Drillia distans Conrad, A.
Drillia pusilla Ravenel, A.
Drillia gracilina Dall n. sp., A.
Drillia, like hoplophorus Dall, A.
Cancellaria carolinensis Emmons, A.
*Oliva literata Lamarck, var.? A.
*Olivella mutica Say, A.
Scaphella Trenholmi Tuomey and Holmes, A.
Turbinella sp., near polygonata Heilprin, A.
Mitra Willcoxii Dall, A.
Fasciolaria rhomboidea Rogers, A.
Fasciolaria Sparrowi Emmons, A.
Busycon scalarispira Conrad, A.
Busycon var. incile Conrad, A.
Busycon var. æpynotum Dall, A.
Busycon maximum Conrad, A.
Busycon var. tudiculatum Dall, A.
Solenosteira Vaughani Dall, J.
Ecphora quadricostata Say, A, L.

Latirus filicatus Conrad, A.
Fusus exilis Conrad, A.
Ptychosalpinx laqueata Conrad, A.
Nassa multilineata Emmons, A.
Anachis camax Dall, A.
Eupleura miocenica Dall, A.
Scala, near acicula Lea, A.
Turbonilla (Chemnitzia), two sp., J.
Turbonilla (Pyrgiscus), three sp., C.
Turbonilla (Strioturbonilla), three sp., J.
Turbonilla (Dunkeria), one sp., J.
Turbonilla (Lancea), three sp., 1J., 2C.
Turbonilla (Tragula), one sp., C.
Cassis (Sconsia) Hodgei Conrad, A.
Cerithium Burnsii Dall, A.
Modulus compactus Dall, A.
Petaloconchus sculpturatus H. C. Lea, A.
Tuba acutissima Dall, A.
Turritella variabilis Conrad, A.
Crucibulum constrictum Conrad, A.
*Crepidula fornicata Say, A.
Crepidula costata Morton, A.
*Crepidula aculeata Gmelin, D.
*Crepidula plana Say, A.
Lunatia interna Say, A.
Neverita coënsis Dall, C.
Neverita percallosa Conrad, A.
Calliostoma aluminium Dall, A.
Fissuridea catilliformis Rogers, A.

Dentalium attenuatum Say, A.
Dentalium carolinense Conrad, F.
Cadulus thallus Conrad, A.
Cadulus floridanus Dall, A.
Cadulus (var.?) Burnsii Dall, A.

Leda trochilia Dall, A.
Yoldia tarpeia Dall, A.
Glycymeris subovata Say, A.
Scapharca scalaris Conrad, A.
Scapharca lienosa Say, A.
Scapharca idonea Conrad, A.
Scapharca aresta Dall, A.
Scapharca campsa Dall, A.
Scapharca clisea Dall, W.
Pteria multangula H. C. Lea, A.
Ostrea compressirostra Say, A.
Ostrea sculpturata Conrad, D.
Pecten eboreus Conrad, A.
Amusium Mortoni Ravenel, A.
Pandora (Clidiophora) crassidens Conrad, A.
Thracia (Conradi Couthouy var.?) Harrisi Dall, A.
Crassatellites melinus Conrad, var., A.
Crassatellites undulatus Say, A.
Astarte floridana Dall, A.
*Chama congregata Conrad, J.
Chama striata Emmons, J.
Echinochama arcinella Linné, D, W.
Carditamera arata Conrad, A, J, D.
Carditamera Vaughani Dall, J, A.
Cyclocardia granulata Say, A, J.
*Pleuromeris tridentata Say, C.
Phacoides cribrarius Say, A, J.
Phacoides contractus Say, A.
Phacoides, near filosus Stimpson, A.
Phacoides crenulatus Conrad, A.
*Divaricella quadrisulcata Orbigny, J.
Diplodonta acclinis Conrad, W.
Cardium acutilaqueatum Conrad, A.
Cardium, near isocardia Lamarck, A.
Cardium Waltonianum Dall, W.
Cardium pansatrum Dall, W.
Cardium virginianum Conrad, A.
*Lævicardium serratum Linné, A.
Dosinia obliqua Dall, A.
*Dosinia elegans Conrad, A.
Transennella caloosana Dall, J.
Gouldia metastriata Conrad, J.
Macrocallista reposta Conrad, J.
Agriopoma Sayana Conrad, A, J.

Chione erosa Dall, J.
Chione cortinaria Rogers, J.
Lirophora ulocyma Dall, A, J.
Lirophora xesta Dall, A.
*Lirophora latilirata Conrad, J.
*Timoclea grus Holmes, J.
Venus tridacnoides Lamarck, A, J.
*Parastarte triquetra Conrad, J.
Tellina sp., A.
Angulus acalyptus Dall, W.
Macoma alumensis Dall, A.
Semele alumensis Dall, A.
*Ensis directus Conrad, A.
Ensis ensiformis Conrad, K.
Spisula marylandica Dall, W.
Mulinia congesta Conrad, A, D.
Mulinia Milesii Holmes, A.
Rangia clathrodonta Conrad, A.
Ervilia lata Dall, W.
Corbula nucleata Dall, A, W.
Corbula inæqualis Say, A.
Corbula heterogenea Guppy, A.
Panopea Goldfussi Wagner, A.

Terebratula sp. ind., J.
Argyrotheca Schucherti Dall, J.

THE DUPLIN MIOCENE OF NORTH CAROLINA.

These beds were first brought to the attention of paleontologists by Mr. J. T. Hodge in 1841,* from whose collections Conrad described a considerable number of species. Mr. Frank Burns, of the United States Geological Survey, under my direction visited the locality and made a thorough search at the limestone sink known as the "Natural Well" and in the vicinity of the adjacent village of Magnolia. A summary of what is known in regard to the geology of the vicinity will be found in Bulletin 84, United States Geological Survey, pp. 72–3, 1892. Kerr and Emmons in their reports on the geology of North Carolina have also referred to these beds in some detail.

Mr. Burns obtained nearly three times the number of fossils which had been previously known from this locality. A study of these indicates their general parallelism with the upper or Yorktown Miocene of Virginia, with which their deposition may have been partially synchronous. The fossil species are, however, largely distinct from those of the Yorktown beds and of a more tropical aspect. It is probable that in Miocene times, as at the present day, there was a difference in the marine faunas of the two regions, that at Yorktown and Suffolk being more allied to the subjacent temperate fauna of the older Miocene of Maryland and Virginia, while that in North Carolina contained more southern types. Yet even this seems hardly sufficient to account for more than part of the difference. It is probable that with the elevation of the Gulf and Florida coasts, which closed the deposition of the cold-water Miocene on those

* Am. Journ. Sci., 1st Ser., xli., pp. 335–344, 1841.

shores, the changes in ocean currents which made the water warmer and invited the return of the subtropical fauna, banished at the end of the Oak Grove epoch, extended at least as far north as North Carolina. To this change I ascribe part of the new aspect of the Duplin fauna, which would thus be due to the combination of two factors. From this state of affairs we gather an explanation of the curious fact that the Duplin fauna is to some extent more like the Oak Grove fauna than the latter is to the Alum Bluff Miocene. Thus only about one per cent. of the Oak Grove species are found in the Alum Bluff Miocene, while the Duplin beds contain three per cent. of species identical with Oak Grove forms.

Thirty-nine per cent. of the species of the Alum Bluff Miocene also occur in the Duplin beds, but thirty-one per cent. of the whole Duplin fauna is peculiar to that region and gives a distinctive character to it. The total number of species is three hundred and thirty-one, which is, theoretically, about ninety-four per cent. of the number of species which might normally be expected there.

LIST OF UPPER MIOCENE SPECIES FROM NORTH CAROLINA.

This list contains those believed to be of the Duplin horizon; a few of which the exact location in the North Carolina Miocene is not known are preceded by a dagger. Those preceded by an asterisk are supposed to survive to the recent fauna. Those species authentically collected at the Duplin well or the adjacent village of Magnolia by Burns are followed by a D; those from Wilmington, North Carolina, by a W; from Cape Fear River by F. Names omitted which appear in the literature are either present here in a corrected form or do not belong to the fauna, as far as positively known.

*Tornatina canaliculata Say, D.
Tornatina myrmecoön Dall, D.
Retusa (Cylichnina) duplinensis Dall, D.
Retusa (Cylichnina) microtrema Dall, D.
Terebra unilineata Conrad, D.
Terebra (Oxymeris) carolinensis Conrad, D.
†Terebra (Oxymeris) Emmonsi Dall.
Terebra (Oxymeris) indenta Conrad, D.
*Terebra (Oxymeris) protexta Conrad, D.
*Terebra (Oxymeris) dislocata Say, D.
Conus adversarius Conrad, D.
Conus marylandicus Green, D.
Pleurotoma (Cymatosyrinx) lunata Lea, F.
†Pleurotoma communis Conrad.
†Drillia virginiana Conrad.
†Drillia elegans Emmons.
†Drillia flexuosa Emmons.
Glyphostoma Johnsoni Dall, F.
Cancellaria Conradiana Dall var. rotunda, D.
†Cancellaria lunata Conrad.
†Cancellaria perspectiva Conrad.
Cancellaria (Trigonostoma) carolinensis Emmons, F.
*Oliva litterata Lamarck, D.
†Oliva idonea Conrad.
*Olivella mutica Say, D.
Olivella ancillariæformis Lea, F.

Marginella antiqua Redfield.
Marginella contracta Conrad.
Marginella ovata Emmons, D.
Scaphella Trenholmi Tuomey and Holmes, D.
*Aurinia dubia Broderip, D.
Aurinia mutabilis Conrad, D.
Aurinia obtusa Emmons, D.
Mitra carolinensis Conrad, D.
Fasciolaria rhomboidea Rogers, D.
Fasciolaria Sparrowi Emmons, D.
Fasciolaria acuta Emmons, D.
Fasciolaria elegans Emmons, D.
*Fasciolaria gigantea Kiener, D.
Busycon var. incile Conrad, D.
Busycon var. excavatum Conrad, D.
Busycon coronatum Conrad, D.
Busycon var. rugosum Conrad, D.
Busycon maximum Conrad, D, W.
*Busycon perversum Linné, D.
Ecphora quadricostata Say, New Berne.
Fusus equalis Emmons, D.
†Fusus exilis Emmons non Conrad(?).
†Fusus lamellosus Emmons(?).
Celatoconus nux Dall, D, F.
Nassa Johnsoni Dall, D, F.
*Nassa consensa Ravenel, F.
Nassa bidentata Emmons, D.
Ptychosalpinx multirugata Conrad, D.
Ilyanassa porcina Say, D.
Ilyanassa schizopyga Dall, F.
Ilyanassa arata Say, D.
Ilyanassa isogramma Dall, F, W.
Ilyanassa granifera Conrad, D.
Ilyanassa var. sexdentata Conrad, W, D, F.
Anachis? interrupta Conrad, D.
Anachis styliola Dall, F.
Astyris sp., D.
*?Murex pomum Gmelin, F (Emmons).
*?Murex rufus Lamarck, F (Emmons).
Pterorhytis umbrifer Conrad, F.
Urosalpinx trossulus Conrad, D.
†Scala curta Emmons.
*†Scala multistriata Say.
Longchæus arenosus Conrad, D.
Longchæus sp., D.
Turbonilla (Turbonilla) sp., D.
Turbonilla (Chemnitzia), four sp., D.
Turbonilla (Chemnitzia), one sp., F.
Turbonilla (Pyrgiscus), two sp., D.
Turbonilla (Pyrgiscus) sp., F.
Turbonilla (Pyrgiscus), three sp., D, F.
Turbonilla (Pyrgiscus) protracta Dall, F.
Turbonilla (Strioturbonilla), three sp., D, F.
Turbonilla (Dunkeria) sp., D.
Turbonilla (Dunkeria) sp., D, F.
Turbonilla (Lancea), two sp., D.
Odostomia sp., D.
Odostomia (Egila) sp., D.
Odostomia (Chrysallida) sp., D.
Odostomia (Heida) sp., D.
Odostomia (Heida) attenuata Dall, F.
Odostomia (Evalea) sp., D.
Sconsia Hodgei Conrad, D.
Cypræa carolinensis Conrad, D.
*Trivia pediculus Linné, F.
*Erato Maugeriæ Gray, F.
*Triforis melanura C. B. Adams, D.
†Triforis monilifera H. C. Lea?.
Seila Adamsi H. C. Lea, D.
*Cerithiopsis subulata Montagu, D.
†Cerithiopsis Emmonsi Conrad.
Bittium annettæ Dall, F.
*Cæcum floridanum Stimpson, D.
Cæcum var. compactum Dall, F.
*Cæcum coronellum Dall, F.
*Cæcum tortile Dall, F.
Cæcum ibex Dall, F.
*Cæcum cooperi S. Smith.
Serpulorbis granifera Say, D.

Serpulorbis var. tenera Dall, D.
†Vermetus carolinensis Conrad.
Turritella etiwanensis Tuomey and Holmes, F.
Turritella Holmesii Dall, F.
Turritella Burdani Tuomey and Holmes, F.
Turritella æquistriata Conrad.
†Turritella constricta Emmons.
Litorina carolinensis Conrad, D.
†Litorina lineata Emmons, not Gmelin.
Fossarus lyra Conrad, D.
*†Isapis anomala C. B. Adams.
*Solarium granulatum Lamarck, D.
Rissoa (Onoba) geræa Dall, F.
Rissoina Johnsoni Dall, F.
*Adeorbis supranitidus S. Wood, D.
*Adeorbis Orbignyi Fischer, D.
Adeorbis concavus H. C. Lea, D, F.
Adeorbis Holmesii Dall, D.
Adeorbis Leai Dall, D.
*Crucibulum costatum Say, D.
*Crucibulum auricula var. spinosum Sowerby, D.
Crucibulum constrictum Conrad, D.
Crucibulum multilineatum Conrad, D.
Calyptræa trochiformis Lamarck, D, W.
*Calyptræa centralis Conrad, D.
*Crepidula fornicata Say, D.
*†Crepidula plana Say.
*Xenophora conchyliophora Born, F.
*Natica canrena Linné, W.
Polynices percallosa Conrad, D.
Lunatia interna Say, D.
Lunatia perspectiva Rogers, D.
Macromphalina duplinensis Dall, D.
Chlorostoma exoletum Conrad, D, F.
Gibbula americana Dall, D.
Calliostoma philanthropus Conrad, F.
Calliostoma var. eliminatum Dall, F.
Calliostoma Mitchelli Conrad, D.
Calliostoma Ruffini H. C. Lea, F.
Calliostoma Willcoxianum Dall, D.
Calliostoma virginicum Conrad, F.
Calliostoma distans Conrad, F.
Calliostoma cyclus Dall, D.
Pseudorotella milium Dall, D.
Solariorbis undula Dall, D.
Solariorbis duplinense Dall, D.
Solariorbis steiratum Dall, F.
Solariorbis vortex Dall, F.
Solariorbis collinus Dall, F.
Cochliolepis nautiliformis Holmes, D.
*Cochliolepis striata Stimpson, D, F.
*Episcynia multicarinata Stimpson, D, F.
Molleria duplinensis Dall, D.
Fissuridea carolinensis Conrad, F.
Fissuridea chipolana Dall, D.
Fissuridea nucula Dall, D.
†Dentalium carolinense Conrad.
Dentalium Danai Meyer, var., D.
*Dentalium disparile Orbigny, D.
Dentalium attenuatum Say, D.
Cadulus thallus Conrad, D.
Nucula taphria Dall, D.
Leda hypsoma Dall, D.
*Leda acuta Conrad, W, D, F.
*Glycymeris pennacea Lamarck, D.
*Glycymeris americana Defrance, D.
Glycymeris subovata Say, D.
Glycymeris var. plagia Dall, D, W.
*Glycymeris pectinata Gmelin, D.
Glycymeris duplinensis Dall, D.
†Barbatia propatula Conrad.
Barbatia centenaria Say, D.
*Fossularca Adamsi Smith, D.
Noëtia limula Conrad, W.
Noëtia incilis Say, D.
Scapharca scalaris Conrad, D.
Scapharca lienosa Say, D.
Scapharca carolinensis Wagner, D.

Scapharca improcera Conrad, D.
Scapharca buccula Conrad, D.
Scapharca plicatura Conrad, D.
†Scapharca subrostrata Conrad.
Atrina Harrisii Dall, D.
Ostrea compressirostra Say, D.
Ostrea trigonalis Conrad, Edgecombe County.
Ostrea sculpturata Conrad, D, Neuse River.
Pecten (Lyropecten) var. septenarius Say, D.
Pecten (Lyropecten) edgecombensis Conrad.
Pecten (Plagioctenium) eboreus Conrad, D.
Amusium Mortoni Ravenel, D.
Plicatula marginata Say, D.
Lima carolinensis Dall, D.
*Placunanomia plicata Tuomey and Holmes, D.
*Anomia simplex Orbigny, D.
Mytilus Conradinus Orbigny, D.
Modiolus Ducateli Conrad, D.
Crenella duplinensis Dall, D.
Modiolaria carolinensis Dall, D.
Margaritaria abrupta Conrad, D.
*Pandora (Clidiophora) trilineata Say, D.
Pandora (Clidiophora) crassidens Conrad, D.
Pandora (Kennerleyia) arenosa Conrad, D.
Verticordia Emmonsi Dall, D.
Pseudocyrena dupliniana Dall, D.
Corbicula densata Conrad, F.
Crassatellites undulatus Say, D.
Crassatellites psychopterus Dall, D.
*Crassatellites Gibbesii Tuomey and Holmes, D.
*Crassinella lunulata Conrad, D.
Crassinella duplinianus Dall, D.
Astarte undulata Say, D.
Astarte concentrica Conrad, D.
?Astarte lyrata Conrad, D.
Carditamera arata Conrad, D.
Cyclocardia granulata Say, D.
*Pleuromeris tridentata Say, D.
*Pteromeris perplana Conrad, D.
Pteromeris var. abbreviata Conrad, D.
Chama corticosa Conrad, F.
*Chama congregata Conrad, D.
Chama striata Emmons, D.
Codakia (Jagonia) speciosa Rogers, D.
Codakia (Jagonia) magnoliana Dall, D.
Phacoides densatus Conrad, D.
Phacoides multistriatus Conrad, D.
Phacoides cribrarius Say, D.
Phacoides anodonta Say, D.
Phacoides contractus Say, D.
*Phacoides radians Conrad, D.
Phacoides crenulatus Conrad, D.
Phacoides Tuomeyi Dall, D.
*Divaricella quadrisulcata Orbigny, D.
*Diplodonta nucleiformis Wagner, D.
Diplodonta acclinis Conrad, D.
Sportella constricta Conrad, D, F.
*Sportella protexta Conrad, D, F, W.
*Anisodonta carolina Dall, D.
Hindsiella carolinensis Dall, D.
Hindsiella acuta Dall, D.
Erycina carolinensis Dall, D, W, F.
Bornia triangula Dall, D.
Bornia rota Dall, D.
Rochefortia Stantoni Dall, D, W.
Rochefortia Stimpsoni Dall, D.
Aligena æquata Conrad, D, W.
Aligena minor Dall, D.
*Cardium isocardia Conrad, W.
Cardium acutilaqueatum Conrad, D.
Cardium laqueatum Conrad, D.
*Cardium robustum Solander, W.
*Cardium medium Linné, D.

*Papyridea semisulcata Gray, D.
Lævicardium sublineatum Conrad, W, D.
Isocardia fraterna Say, Harford County.
Isocardia carolina Dall, Edgecombe County.
*Dosinia elegans Conrad, F.
Transennella carolinensis Conrad, D.
Gouldia metastriata Conrad, D.
Macrocallista reposta Conrad, D.
Callocardia Sayana Conrad, D.
Pitaria filosina Dall, D.
Chione cribraria Conrad, D.
*Lirophora latilirata Conrad, D.
*Timoclea grus Holmes, D.
Anomalocardia dupliniana Dall, D.
Venus plena Conrad, D.
Venus tridacnoides Lamarck, D.
*Venus campechensis Gmelin, D.
Gemma magna Dall, D.
Gemma trigona Dall, D.
Petricola carolinensis Conrad, D.
Cooperella Carpenteri Dall, D.
Tellina arctata Conrad, D.
Tellina lintea Conrad, New Berne.
Angulus dupliniana Dall, W, D.
Angulus propetenella Dall, W.
Angulus macilenta Dall, D.
Angulus umbra Dall, W, D.
*Strigilla flexuosa Say, D.
Metis magnoliana Dall, D.
Macoma Conradi Dall, D.
Psammacoma Holmesii Dall, D.
Cumingia medialis Conrad, D.
*Abra æqualis Say, W.
Semele carinata Conrad, D.
Semele bella Conrad, D, W.
Semele bella var. duplinensis Dall, D.
Semele bella var. appressa Dall, D.
*Semelina nuculoidea Conrad, D, W.
Tagelus carolinensis Conrad, W.
Asaphis centenaria Conrad, D.
Donax Emmonsi Dall, D, F.
*Donax fossor Say, D, F.
Donax æquilibrata Dall, F.
*Ensis directus Conrad, D.
Ensis ensiformis Conrad, D.
Spisula duplinensis Dall, D.
Spisula curtidens Dall, D.
Spisula magnoliana Dall, D.
Spisula subparilis Conrad, W.
Mulinea congesta Conrad, D.
Mulinea lateralis Say, D.
Mulinea Milesii Holmes, D.
Rangia clathrodonta Conrad, D.
Ervilia lata Dall, D.
*Paramya subovata Conrad, D.
Tugoniopsis compacta Dall, D.
Sphenia dubia H. C. Lea, D.
Corbula heterogenea Guppy, D.
Corbula inæqualis Say, D.
Corbula cuneata Say, D.
*Saxicava arctica Linné, D.
*Panopea reflexa Say, D.
Gastrochæna ligula H. C. Lea, D.

Discinisca lugubris Conrad, D.

THE CALOOSAHATCHIE PLIOCENE.

The area over which the Pliocene outcrops in southwestern Florida is cut by various streams, the Caloosahatchie, Alligator Creek, Shell Creek, Peace Creek, and the Myakka River, all debouching in the vicinity of Charlotte Harbor. The mode of occurrence of these beds was described by Professor Angelo Heilprin in the first volume of these Transactions from explorations by

Mr. Willcox and himself. He recognized in them the first distinctive marine Pliocene discovered in the United States. The present writer in company with Mr. Willcox visited the Caloosahatchie, and subsequent collections were made, especially at Shell Creek, by Mr. Frank Burns, of the United States Geological Survey. A rather full geological account is given by the writer in Bulletin 84 of the United States Geological Survey, pp. 142-149, and the area over which outcrops of the Pliocene have been recognized is delineated on the map which accompanies that Bulletin and is reprinted by the courtesy of the Director of the Survey in Part II. of this volume. It is therefore unnecessary to recapitulate the information which has already been printed as above mentioned. In brief, these beds consist of layers of marl conformable to each other, and sometimes gently arched in long, low waves, but otherwise little disturbed. They are unconformably overlaid by Pleistocene sands, and, of course, the upper portion of the marls contains more recent species than the lower, and is especially notable for the profusion of specimens of *Chione cancellata, Planorbis, Physa,* and other freshwater or estuarine fossils.

The specimens are usually in a beautiful state of preservation, though occasionally strings or layers of drusy silica have formed in the marl, entangling the fossils. The Pliocene beds dip gently to the westward, so that those portions near the sea are newer than those outcropping near the headwaters of the streams. The older beds, probably because deposited in deeper water, have a larger fauna than the newer ones. This is illustrated by the following comparison, in the order of the distance from the coast of the locality collected at.

1. Myakka River. Total, seventy-three species, of which seventy-two per cent. are recent and none peculiar to the locality.
2. Alligator Creek. Total, seventy-three species, of which sixty-three per cent. are recent and none peculiar.
3. Shell Creek. Total, two hundred and fifty-six species, of which fifty-nine per cent. are recent and seven per cent. peculiar.
4. Caloosahatchie River. Six hundred and thirty-nine species, of which forty-eight per cent. are recent and twenty-eight per cent. are peculiar.

The total number of species enumerated from the Floridian Pliocene is six hundred and thirty-nine, of which three hundred and fourteen are known as recent, thirty-two are known from the lower Miocene of Florida, Virginia, and Maryland, one hundred and fourteen from the upper Miocene of

North Carolina, seventy-one from the Pliocene of South Carolina, and thirty-one from the Pliocene of North Carolina. Of species only known from the Pliocene of Florida there are two hundred and fifty-six.

The epoch of the Pliocene in Florida was one of tropical conditions. This is indicated not only by the large number of species included in the fauna, but by their character. With the fauna of the cool temperate Chesapeake epoch the Caloosahatchie fauna has only thirty-two species in common, but with the warm temperate climate of the Duplin epoch one hundred and fourteen. With the co-temporary but cooler-water Waccamaw fauna there are only seventy-one links, and with the later, more northern, and still cooler Croatan fauna these have diminished to thirty-one.

LIST OF FLORIDIAN PLIOCENE FOSSILS.

Those marked C are from the outcrops on the Caloosahatchie; S, those from Shell Creek; A, those from Alligator Creek; M, those from the Myakka River. Those marked W are also authentically known from the Pliocene of the Waccamaw beds of the Carolinas, and the asterisk denotes their persistence to the recent fauna of the coast.

*Polygyra microdonta Pfr., C.
*Succinea luteola Gould, C.
*Glandina truncata Gmelin, C.
*Glandina truncata var. ovata Dall, C.
*Glandina truncata var. macer Dall, C.
Planorbis Conanti Dall, C, S.
Planorbis Disstoni Dall, C, S.
*Planorbis exacutus Say, C.
*Ameria scalaris Jay, C.
Physa Meigsii Dall, C, S, M.

*Actæon punctostriatus C. B. Adams, C, M.
Actæon pomilius Conrad? C.
Actæon myakkanus Dall, M, C.
Ringicula floridana Dall, C.
Ringicula Guppyi Dall, C, A, S.
*Tornatina canaliculata Say, C, M, S, A, W.
Cylichnella Gabbi Dall, C, M.
Cylichnella ovum-lacerti Guppy? C.
*Retusa sulcata Orbigny, C.
*Atys Sandersoni Dall, C, S, M.
*Bulla striata Bruguière, C, S, M.
*Haminea virescens Sowerby, C.
Terebra (Oxymeris) dislocata Say, C, S, W, M.
*Terebra (Oxymeris) concava Say, C, S, W, M.
*Terebra (Oxymeris) protexta Conrad, C, S, A, W, M.
Conus adversarius Conrad, C, A, S.
*Conus proteus Hwass, C.
*Conus Pealii Green, C, S.
*Conus floridanus Gabb, C, S, A.
*Conus pygmæus Reeve, C, S, M.
*Conus daucus Linné, C, S.
*Pleurotoma albida Perry, C.
Drillia (Cymatosyrinx) lunata Lea, C, A.
*Drillia (Cymatosyrinx) æpynota var. acila Dall, C.
Drillia (Cymatosyrinx) myrmecoon Dall, C.

*Drillia (Cymatosyrinx) Moseri Dall, C.
*Drillia (Cymatosyrinx) pagodula Dall, C.
*Drillia ostrearum Stearns, C, S, M.
Drillia abundans Conrad, C.
*Drillia perrugata Dall, C.
Drillia perspirata Dall, C.
Drillia acurugata Dall, C.
Drillia acucincta Dall, C.
*Drillia ebenina Dall, C, S.
*Drillia quadrifasciata Gray var. quadrilineata C. B. Adams, C.
Drillia sedilia Dall, C.
Drillia podagrina Dall, C.
Drillia piscator Dall, C.
Drillia edilia Dall, C.
Drillia bigemma Dall, C.
*Drillia leucocyma Dall, C, S.
*Drillia albomaculata Orbigny, C.
Drillia perpolita Dall, C.
Drillia scissurata Dall, C.
*Drillia Simpsoni Dall, C.
Drillia hoplophorus Dall, C, W.
*Drillia aphanitoma Dall, C, S.
Drillia schismatica Dall, S.
Drillia sigela Dall, S.
*Cythara balteata Reeve, C.
*Cythara psila Bush, C.
Cythara terminula Dall, C.
Cythara metria Dall, S.
Cythara micromeris Dall, S.
Daphnella cingulata Dall, C, S.
*Daphnella elata Dall, C.
Daphnella modesta Dall, C.
*Glyphostoma gratula Dall var. incile Watson, C.
Glyphostoma Watsoni Dall, C.
Glyphostoma scoptes Dall, S.
*Mangilia quadrata Reeve, C.
*Mangilia eritima Bush, C.
*Mangilia monilifera Sowerby, C.
*Mangilia melanitica Dall var. oxia Bush, C.
*Mangilia plicosa C. B. Adams, C.
*Mangilia stellata Stearns, C.
*Mangilia rubella Kurtz and Stimpson, C.
*Mangilia limonitella Dall, M.
*Pleurotomella chariessa Watson var. pistillata Dall, C.
Pleurotomella, two sp. ind., C.
*Cancellaria Conradiana Dall, C, S, M.
*Cancellaria tenera Philippi, C, S.
Cancellaria sericea Dall, C, S.
*Oliva literata Lamarck, C, S, W, A.
*Olivella mutica Say, C, S, M.
*Olivella nitidula Dillwyn, C, S.
*Olivella rotunda Dall, S.
Marginella præcursor Dall, C.
*Marginella virginiana Conrad, C.
Marginella pardalis Dall, C, S.
Marginella floridana Dall, C.
*Marginella Lavalleana Orbigny, C.
*Marginella limatula Conrad, C, S, W.
*Marginella rostrata Redfield, C.
Marginella Willcoxiana Dall, C, S.
*Marginella prunum Gmelin, C.
*Marginella denticulata Conrad, C.
*Marginella aureotincta Stearns, C.
*Marginella bella Conrad, C.
Marginella eulima Dall, C, S.
Marginella onchidella Dall, C, S.
*Marginella pallida Donovan, C.
*Marginella avenacea Deshayes, C.
*Marginella styria Dall, C.
*Marginella gravida Dall, C.
*Marginella apicina Menke, M.
*Marginella (Closia) ovuliformis Orbigny, C.
Marginella (Closia) amiantula Dall, C.
*Marginella (Closia) lacrymula Gould, M.
Scaphella floridana Heilprin, C, S, A.

*Aurinia dubia Broderip, C.
Perplicaria perplexa Dall, C, S.
Mitra (Pleioptygma) lineolata Heilprin, C, S, W.
*Mitra wandoënsis Holmes, C, W.
Mitra Holmesii Dall, C.
Mitra Willcoxii Dall, C, M.
Mitra sp. ind., C.
Mitromorpha cincta Dall, C.
Mitromorpha pygmæa Dall, C.
Turbinella regina Heilprin, C, S.
Turbinella scolymoides Dall, C, S.
Vasum horridum Heilprin, C, S.
Liochlamys bulbosa Heilprin, C.
*Fasciolaria tulipa Linné, C, M.
Fasciolaria apicina Dall, C.
*Fasciolaria distans Lamarck, M.
Fasciolaria monocingulata Dall, C.
Fasciolaria scalarina Heilprin, C, S.
*Fasciolaria gigantea Kiener, C, S, A.
Latirus tessellatus Dall, C.
Latirus hypsipettus Dall, C.
*Busycon pyrum Dillwyn, C, S, M.
Busycon pyrum var. excavatum Conrad, C, W.
Busycon planulatum Dall, C, S.
Busycon maximum Dall, C.
Busycon maximum var. rapum Heilprin, C.
*Busycon perversum Linné, C, M, W.
Busycon echinatum Dall, C.
Melongena subcoronata Heilprin, C.
Melongena subcoronata var. aspinosa Dall, C.
*Melongena corona Gmelin, M.
Solenosteira Mengeana Dall, C, S.
Fusus caloosaënsis Heilprin, C, S.
*Tritonidea auritula Link, C, W, A.
Phos parvus Adams var. intricatus Dall, C.
*Engina turbinella Kiener, S, C.
*Nassarina glypta Bush, C, S.
*Nassa vibex Say, C, S, M.
*Nassa consensa Ravenel, C, S.
*Nassa ambigua var. antillarum Orbigny, C, S.
Nassa bidentata Emmons, C, S.
Nassa Lapenotieri Dall, C.
Nassa caloosaënsis Dall, C.
*Columbella rusticoides Heilprin, C.
Columbella cosmia Dall, S.
Anachis avara Say var. caloosaënsis Dall, S, C.
Anachis avara var. amydra Dall, C, S.
Anachis camax Dall, C, S.
Anachis ithitoma Dall, C.
*Astyris lunata Say, C, M.
*Astyris profundi Dall, C, S.
Astyris profundi var. minor Dall, C, S.
*Astyris fusiformis Orbigny, C, S.
*Astyris multilineata Dall, C.
*Æsopus Stearnsii Tryon, C.
*Murex messorius Sowerby, C, A.
*Murex breviformis Lamarck, C.
*Murex rufus Lamarck, C, A.
*Murex micromeris Dall, C.
*Murex pomum Gmelin, C, A.
Murex (Pteropurpura) textilis Gabb, C, S.
Murex (Pterorhytis) fluviana Dall, S.
*Eupleura caudata Say, C.
*Urosalpinx perrugatus Conrad, S, M.
Urosalpinx trossulus Conrad, C, S.
Urosalpinx trossulus var. subsidus Dall, C, S.
*Muricidea floridana Conrad, C, S.
*Pseudoneptunea multangula Philippi, C, S, M.
*Ocinebra (Favartia) alta Dall, C, S.
*Ocinebra (Favartia) cellulosa Conrad, C.
Aspella engonata Dall, S.
Aspella senex Dall, S.

Typhis floridanus Dall, C.
*Coralliophila abbreviata Lamarck, C.
Coralliophila lepidota Dall, C.
*Scala uncinaticosta Orbigny, C.
*Scala turricula Sowerby, C, S.
*Scala sayana Dall, C.
*Scala lineata Say, C.
Scala (Opalia) Debouryi Dall, C.
*Eulima conoidea Kurtz and Stimpson, C.
*Eulima subcarinata Orbigny, C.
*Eulima gracilis C. B. Adams, C.
*Eulima intermedia Cantraine, M.
*Eulima (Melanella) arcuata C. B. Adams, C.
*Eulima (Liostraca) acuta Sowerby, C.
Eulima (Liostraca) rectiuscula Dall, C.
Niso Willcoxiana Dall, C.
*Longchæus crenulatus Holmes, C, S, M, W.
Pharcidella sp., S, M.
Triptychus sp., C.
Eulimella sp., C.
Turbonilla, two sp., S.
Turbonilla sp., C.
Turbonilla (Chemnitzia) sp., C, M.
Turbonilla (Chemnitzia), four sp., C, S.
Turbonilla (Chemnitzia) sp., S, W.
Turbonilla (Chemnitzia), three sp., C.
Turbonilla (Pyrgiscus), five sp., S, C, M.
Turbonilla (Pyrgiscus) sp., C, W.
Turbonilla (Pyrgiscus), two sp., C.
Turbonilla (Strioturbonilla) sp., C, W.
Turbonilla (Strioturbonilla) sp., S.
Turbonilla (Strioturbonilla) sp., M.
Turbonilla (Strioturbonilla), five sp., C.
Turbonilla (Dunkeria) sp., S.
Turbonilla (Dunkeria) sp., C, S.
Turbonilla (Dunkeria) sp., C, W.
Odostomia sp., C.
Odostomia (Salassia) sp., C.
Odostomia (Trabecula) sp., S.
Odostomia (Chrysallida) sp., C.
Odostomia (Chrysallida), C, S.
Odostomia (Chrysallida), three sp., S.
Odostomia (Oscilla) sp., S, C.
Odostomia (Heida) caloosaënsis Dall, C, S.
Odostomia (Scalenostoma) sp., S.
Odostomia (Evalea) sp., S.
*Lampusia pilearis Lamarck, C.
Lampusia sp. ind., C.
*Colubraria lanceolata Menke, C, S.
*Pyrula papyratia Say, C, M.
Siphocypræa problematica Heilprin, C. S.
*Trivia suffusa Gray, C, S, W.
*Trivia pediculus Linné, C, W.
*Trivia globosa Gray, C.
*Erato Maugeriæ Gray, C, S.
*Strombus pugilis Linné var. alatus Gmelin, C, S, A, M.
*Strombus pugilis Linné, C, S, A.
Strombus Leidyi Heilprin, C.
*Triforis nigrocincta C. B. Adams, C, S, W.
*Triforis modesta C. B. Adams, C, S, A.
*Triforis mirabilis C. B. Adams, S.
*Seila Adamsi H. C. Lea, C, S, M, W.
*Cerithiopsis subulata Montagu, C.
*Cerithiopsis Greenii C. B. Adams, C.
Cerithiopsis floridana Dall, C.
Cerithiopsis scariphus Dall, C.
*Cerithiopsis (Metaxia) tæniolata Dall, C.
Bittium podagrinum Dall, C, S.
*Bittium varium Pfeiffer, C, S.
*Bittium (Alabina) cerithidioide Dall, C.
*Bittium (Alabina) Adamsi Dall, C, S, A.
*Cerithium floridanum Mörch, C.
*Cerithium algicola C. B. Adams, C, S.
*Cerithium muscarum Say, C, M, A.
Cerithium caloosaënse Dall, C, S.
Cerithium callisoma Dall, C.
Cerithium glaphyrea Dall, C.

Cerithium glaphyrea Dall var. litharium Dall, C, S, A.
Cerithium coccodes Dall, C, S.
Potamides (Pyrazisinus) scalatus Heilprin, C, M, S.
*Cerithidea turrita Stearns, C.
Clava caloosaënsis Dall, C, S.
*Goniobasis Hallenbeckii Lea? C.
*Modulus floridanus Conrad, C, M.
*Modulus modulus Linné, C.
*Cæcum floridanum Stimpson, C.
Cæcum floridanum var. compactum Dall, C.
*Cæcum coronellum Dall, C.
*Cæcum regulare Carpenter, C, S, A.
*Cæcum Cooperi S. Smith, C, S.
*Cæcum glabrum Montagu, C.
*Cæcum carolinianum Dall, C.
*Meioceras nitidum Stimpson, C.
Meioceras cingulatum Dall, C, S.
*Vermicularia spirata Philippi, C, S, M, A, W.
*Vermetus (Petaloconchus) irregularis Orbigny, C.
*Vermetus (Petaloconchus) varians Orbigny, C, S, W.
*Vermetus (Petaloconchus) erectus Dall, C.
Turritella subannulata Heilprin, C, S, W.
*Turritella subannulata var. acropora Dall, C, M.
Turritella subannulata var. Burnsii Dall, C.
Turritella subannulata var. intermedia Dall, C.
Turritella subannulata var. perincisa Dall, C.
Turritella perattenuata Heilprin, C, S, M.
Turritella perattenuata var. obsoleta Dall, C.
Turritella perattenuata var. undula Dall, C.
Turritella apicalis Heilprin, C, S, M.
Turritella apicalis var. mediosulcata Heilprin, C.
Turritella apicalis var. cingulata Heilprin, C.
Turritella apicalis var. tensa Dall, C, S.
*Fossarus (Isapis) anomala C. B. Adams, C.
Discohelix (Discosolis) retifera Dall, C, S.
*Vivipara georgiana Lea, C, S.
*Ampullaria (Pomus) hopetonensis Lea, C, S, M.
Paludestrina amnicoloides Pilsbry, C.
Paludestrina umbilicata Pilsbry, C.
*Bythinella Nickliniana Lea var. attenuata Haldeman, C, S.
*Amnicola floridana Frauenfeld var. convexa Pilsbry, C, S.
Amnicola omphalotropis Pilsbry, C, M.
Rissoa lipeus Dall, C.
Rissoa athymorhyssa Dall, S.
Rissoa (Onoba) geræa Dall var. minor Dall, C.
Rissoa (Onoba) callistrophia Dall, C, S.
Rissoa (Onoba) microcharia Dall, C.
*Rissoina Chesneli Michaud, C.
*Rissoina cancellata Philippi, C.
Rissoina decussata Montagu var. planata Dall, C.
*Rissoina lævigata C. B. Adams, C, S.
Adeorbis strigillatus Dall, C.
Adeorbis concavus H. C. Lea, C.
*Assiminea affinis Orbigny, C, S.
*Assiminea Auberiana Orbigny, C, S.
*Cheilea equestris Linné, C.
*Crucibulum auricula Gmelin, C, S, M, W.
*Crucibulum auricula var. costatum Say, C, S.
*Crucibulum auricula var. imbricatum Sowerby, C.
*Crucibulum auricula var. spinosum Sowerby, C, A.

*Crucibulum striatum Say, M.
*Calyptræa centralis Conrad, C.
*Crepidula fornicata Say, C, S, M.
*Crepidula convexa Say, M, A.
Crepidula æsop Dall, S.
*Crepidula aculeata Gmelin, C, S, A.
*Crepidula plana Say, C, M.
*Amalthea antiquata Linné, C.
*Xenophora conchyliophora Born, C, S.
*Natica canrena Linné, C, S, A, M.
*Natica (Cryptonatica) pusilla Say, C, S.
*Polynices (Neverita) duplicatus Say, C, S.
Sigaretus multiplicatus Dall, C, W.
Sigaretus (Eunaticina) carolinensis Dall, C.
*Acmæa punctulata Gmelin, C.
*Phasianella pulchella C. B. Adams, S, W.
*Turbo castaneus Gmelin, C, S.
*Turbo castaneus var. crenulatus Gmelin, C, S.
Turbo rhectogrammicus Dall, C, S.
Astralium præcursor Dall, C, S.
Collonia elegantula Dall, C, S, M.
*Chlorostoma (Omphalius) fasciatum Born, C, S.
Calliostoma Willcoxianum Dall, C, S.
Calliostoma roseolum var. permagnum Dall, C.
*Calliostoma jujubinum Gmelin, C, S.
Liotia (Arene) milium Dall, C.
Liotia (Arene) perarmata Dall, C.
*Liotia (Arene) gemma Tuomey and Holmes, C, S, W.
Teinostoma (Climacia) calliglyptum Dall, S.
Teinostoma (Climacia) radiatum Dall, C.
Teinostoma (Pseudorotella) milium Dall, C, S.
Teinostoma (Pseudorotella) caloosaënse Dall, C.
Teinostoma (Pseudorotella) opsitelotus Dall, C, S.
Teinostoma (Solariorbis) floridanum Dall, C.
Teinostoma (Solariorbis) funiculum Dall, C.
*Cochliolepis parasitica Stimpson, C.
*Episcynia multicarinata Stimpson, C.
Neritina edentula Dall, C, S.
Neritina (Smaragdia) merida Dall, S.
*Lucapinella limatula Reeve, C.
*Lucapina suffusa Reeve, C, A.
Fissuridea carolinensis Conrad, C, S, A.
Fissuridea nucula Dall, C.
Fissuridea caloosaënsis Dall, C, S.
Fissuridea carditella Dall, C.
*Fissuridea alternata Say, C, W, A.
Emarginula Pilsbryi Dall, C.
Subemarginula retiporosa Dall, S.

Chiton Burnsii Dall, S.
*Ischnochiton papillosus C. B. Adams, C.
*Ischnochiton striolatus Gray, C.
*Acanthochites spiculosus Reeve, C.
*Acanthochites pygmæus Pilsbry, C.
*Chætopleura apiculata Say, C.

*Dentalium antillarum Orbigny, M.
*Dentalium disparile Orbigny, C, W.
*Dentalium calamus Dall, C.
*Dentalium oleacinum Dall, C, S.
Dentalium caloosaënse Dall, C, S.
Dentalium prisma Dall, C.
*Dentalium callipeplum Dall, C.
*Cadulus quadridentatus Dall, C.

*Nucula proxima Say, C, S, W, A.
*Leda acuta Conrad, C, S, A, W.
Pleurodon Woodii Dall, C.
*Glycymeris pennacea Lamarck, C.
*Glycymeris americana Defrance, C, W.

*Glycymeris pectinata Gmelin, C, S, W.
Arca Wagneriana Dall, C, S, M.
*Arca occidentalis Philippi, C.
*Arca umbonata Lamarck, C.
Arca aquila Heilprin, C.
Barbatia irregularis Dall, C, S, A.
Barbatia (Acar) millifila Dall, S.
*Barbatia (Acar) reticulata Gmelin, C, A.
*Barbatia (Fossularca) Adamsi Smith, C, S, A, W.
Barbatia (Cucullaria) tæniata Dall, C, S, Croatan.
Noëtia limula Conrad, C, S, W.
Noëtia limula var. platyura Dall, C, A.
Scapharca (Cunearca) scalarina Heilprin, C, S.
Scapharca (Cunearca) alcima Dall, A.
Scapharca lienosa Say, C, S, A, W.
Scapharca improcera Conrad, C, S.
Scapharca plicatura Conrad, W, De Leon Springs.
Scapharca campyla Dall, C, S, A, M.
*Scapharca transversa Say, M.
Scapharca triphera Dall, C.
Scapharca (Anadara) rustica T. and H., C, S, A, M, W.
Scapharca (Anadara) catasarca Dall, S, A.
Pinna caloosaënsis Dall, C.
*Pteria colymbus Bolten, C.
Ostrea compressirostra Say, var.? Peace Creek, Florida.
Ostrea trigonalis Conrad, A, Peace Creek.
Ostrea sculpturata Conrad, C, S, A, W, De Leon Springs.
*Ostrea virginica Gmelin, C, M.
Unio (Unio) caloosaënsis Dall, C.
Pecten Raveneli Dall, C.
Pecten (Nodipecten) nodosus Linné, C, S, W.
Pecten (Nodipecten) caloosaënsis Dall, C, S.
Pecten (Chlamys) Harrisii Dall, C.
*Pecten (Chlamys) exasperatus Sowerby, C, S.
*Pecten (Plagioctenium) gibbus Linné, C, S, A, M.
*Pecten gibbus var. amplicostatus Dall, C, S, A, M.
Pecten (Plagioctenium) eboreus Conrad, C, S, W.
Pecten eboreus var. solarioides Heilprin, C, S.
Pecten eboreus var. senescens Dall, W.
Amusium Mortoni Ravenel, C, S.
Spondylus rotundatus Heilprin, C, S.
Plicatula marginata Say, C, S, A, W.
*Plicatula gibbosa Lamarck, A.
Lima caloosana Dall, C.
*Lima scabra Born, C, S.
*Lima tenera Sowerby, C.
*Lima lima Gmelin, C.
*Anomia simplex Orbigny, C, W, A.
Mytilus Conradinus Orbigny, W.
*Mytilus (Hormomya) exustus Linné, C, S.
*Mytilus (Hormomya) hamatus Say, C.
*Modiolus (Brachydontes) desmissus Dillwyn, C.
Lithophaga sp., A.
*Modiolus (Botula) cinnamomeus Lamarck, C.
*Crenella divaricata Orbigny, C, S.
*Modiolaria lateralis Say, C, S.
Congeria lamellata Dall, C, S.

*Periploma angulifera Philippi, S.
*Cyathodonta semirugosa Reeve, C.
Pandora (Kennerleyia) arenosa Conrad, S.
*Pandora (Clidiophora) trilineata Say, C, W.
Lyonsia acuta Dall, C.

Verticordia Emmonsi Dall, C.
*Cuspidaria (Cardiomya) ornatissima Orbigny, S, C.
*Cuspidaria (Plectodon) granulata Dall, C.

*Coralliophaga coralliophaga Gmelin, C, S.
Astarte (Ashtarotha) concentrica Conrad, W.
Astarte concentrica var. bella Conrad, W.
*Crassatellites (Scambula) Gibbesii T. and H., C, A, W.
Crassatellites (Crassinella) acutus Dall, C, S, A.
*Crassatellites (Crassinella) lunulatus Conrad, C, S, A, W.
Crassatellites (Crassinella) duplinianus Dall, W.
Cyrena (Pseudocyrena) dupliniana Dall, C, S.
Corbicula densata Conrad, W, also Gay Head, Massachusetts.
Cardita (Carditamera) arata Conrad, C, W, S, A, M.
*Cardita (Carditamera) floridana Conrad, C, S.
Cardita (Carditamera) catharia Dall, C.
Venericardia (Cyclocardia) granulata Say, W.
*Venericardia (Pleuromeris) tridentata Say, C, W.
*Venericardia (Pteromeris) perplana Conrad, C, S, W.
Venericardia perplana var. abbreviata Conrad, S, W.
Chama striata Emmons, C, S, W.
Chama Willcoxi Dall, C, S.
Chama crassa Heilprin, C.
Chama caloosana Dall, C, S, A, also Trinidad.
*Echinochama arcinella Linné, C, S, A, De Leon.
Codakia (Jagonia) speciosa Rogers, C, S.
*Codakia (Jagonia) portoricana Dall, C.
*Codakia orbicularis Linné, C, S.
*Lucina chrysostoma Philippi, C, S, A.
*Phacoides pectinatus Gmelin, C, S, A, M.
*Phacoides pensylvanicus Linné, C, S, A.
Phacoides (Pleurolucina) amabilis Dall, C, S.
Phacoides (Cavilucina) trisulcatus Conrad, C, S.
Phacoides (Lucinisca) nassula Conrad var. caloosana Dall, C, S.
Phacoides (Miltha) caloosaënsis Dall, C, S.
Phacoides (Miltha) disciformis Heilprin, C, S.
Phacoides (Pseudomiltha) anodonta Say, C, S, A.
*Phacoides (Callucina) radians Conrad, S, W.
*Phacoides (Parvilucina) multilineatus T. and H., C, S, M, W.
Phacoides (Bellucina) waccamawensis Dall, C, S, W.
Divaricella chipolana Dall, C.
Divaricella compsa Dall, S.
Diplodonta acclinis Conrad, C, W.
Diplodonta caloosaënsis Dall, C, W.
*Diplodonta semiaspera Philippi, C.
Cyrenoida caloosaënsis Dall, C.
*Thyasira trisinuata Orbigny, C, S.
Sportella constricta Conrad, C, S, W.
*Sportella protexta Conrad, C, W.
Sportella compressa H. C. Lea, C.
Anisodonta americana Dall, C.
Erycina carolinensis Dall, C, W.
Erycina (Pseudopythina) protracta Dall, C, W.
Erycina (Pseudopythina) Kurtzii Dall, C.
Pleurodesma floridana Dall, S.
Bornia triangula Dall, C, S.

Bornia lioica Dall, C.
Bornia Mazyckii Dall, C.
*Rochefortia planulata Stimpson, C.
*Rochefortia planulata var. tenuis V. and B., C.
*Montacuta (Orobitella) floridana Dall, C.
Aligena æquata Conrad, C.
Cardium (Trachycardium) Emmonsi Dall, C, S.
*Cardium (Trachycardium) isocardia Conrad, C, M.
Cardium (Trachycardium) œdalium Dall, C, S, A.
Cardium (Trachycardium) Dalli Heilprin, C, S.
*Cardium (Cerastoderma) robustum Solander, C, S, M.
*Cardium (Fragum) medium Linné, C, S, A.
Cardium (Fragum) arestum Dall, C.
Cardium (Trigoniocardia) Willcoxi Dall, C, S.
*Papyridea spinosa Meuschen var. Turtoni Dall, C.
*Papyridea semisulcata Gray, C.
*Lævicardium serratum Linné, C, M, W.
*Lævicardium Mortoni Conrad, C, S.
*Dosinia (Dosinidia) elegans Conrad, C, S, A.
*Dosinia (Dosinidia) discus Reeve, C, S, M.
Transennella caloosana Dall, C, S, M.
Gafrarium (Gouldia) metastriatum Conrad, C, S, W, M.
*Macrocallista nimbosa Solander, C, S, A, M.
*Macrocallista (Chionella) maculata Linné, C, S, A.
Callocardia (Agriopoma) Sayana Conrad, C, W, A.
Pitaria opisthogrammata Dall, S, A.
Cytherea Willcoxi Dall, C.
*Cytherea (Ventricola) rugatina Heilprin, C, S.
*Cyclinella tenuis Recluz, C.
*Chione cancellata Linné, C, S, A, M.
*Chione (Lirophora) latilirata Conrad, C, S, A, W.
*Chione (Timoclea) grus Holmes, C, S.
*Anomalocardia brasiliana Gmelin, S.
Anomalocardia caloosana Dall, C, S, M.
Venus tridacnoides Lamarck, C, S, W.
*Venus mercenaria Linné, C, W.
*Venus campechiensis Gmelin, S, M.
Gemma magna Dall, C, S, W, A.
Gemma trigona Dall, C, W.
*Parastarte triquetra Conrad, C, S, A, M.
*Petricola lapicida Gmelin, C.
*Petricola (Rupellaria) typica Jonas, C, A.
*Tellina (Eurytellina) alternata Say, C, S, W, M.
Tellina (Merisca) æquistriata Say, W, also Croatan.
Tellina (Merisca) caloosana Dall, C.
Tellina (Merisca) dinomera Dall, C.
*Tellina (Cyclotellina) fausta Don., C.
Tellina (Moerella) suberis Dall, C.
Tellina (Angulus) dupliniana Dall, W.
Tellina (Angulus) umbra Dall, C, W.
Tellina (Angulus) propetenella Dall, C, W.
*Tellina (Angulus) Sayi Deshayes, C, W, also Croatan.
Tellina (Angulus) propetenera Dall, C.
*Tellina (Angulus) mera Say, C.
Tellina (Angulus) declivis Conrad, S.
*Tellina (Angulus) tampaënsis Conrad, C.
*Tellina (Scissula) similis Sowerby, C.
Tellina (Scissula) calliglypta Dall, S.
*Tellidora cristata Recluz, C, S.

*?Strigilla pisiformis Linné (Pliocene of Trinidad).
*Strigilla flexuosa Say, C, S.
Metis biplicata Conrad, C?.
Macoma virginiana Conrad, C, W.
*Macoma tenta Say, C.
*Macoma constricta Bruguière, C.
Macoma laxa Dall, C.
*Macoma (Psammacoma) brevifrons Say, C.
Semele carinata Conrad, W.
Semele bella Conrad var. appressa Dall, W.
*Semele proficua Pulteney, C, W.
Semele perlamellosa Heilprin, C, S.
Semele Leana Dall, C, S.
*Semele purpurascens Gmelin C., also Costa Rica.
*Semele bellastriata Conrad, C, S.
*Semele (Semelina) nuculoidea Conrad, C.
*Abra æqualis Say, C, W.
*Cumingia coarctata Sowerby, C.
Psammobia (Gobræus) Wagneri Dall, C, W.
*Tagelus gibbus Spengler, C, W.
*Tagelus divisus Spengler, C, S, A, M, W.
*Donax fossor Say, C, W.
*Ensis directus Conrad, W.
*Psammosolen Cumingianus Dunker, C, S.
Mactra (Mactrotoma) undula Dall, C, S.
*Mactra (Mactrotoma) fragilis Gmelin, C.
Mactra (Mactrotoma) Willcoxi Dall, M.
*Mulinia lateralis Say, C, S, W.
Mulinia caloosaënsis Dall, C, S.
Mulinia sapotilla Dall, C.
*Rangia cuneata Gray, C, S, M, A, W.
*Labiosa lineata Say, C, S.
Ervilia polita Dall, C, S.
*Paramya subovata Conrad, W.
Sphenia attenuata Dall, C.
Corbula (Aloidis) heterogenea Guppy, C, S, A.
Corbula (Aloidis) caloosæ Dall, C, S, M, A.
Corbula (Cuneocorbula) inæqualis Say, W.
Corbula (Cuneocorbula) cuneata Say, C.
Corbula (Cuneocorbula) nucleata Dall, W.
*Corbula (Cuneocorbula) contracta Say, C.
*Corbula (Cuneocorbula) Barrattiana Adams, C, S, W.
*Saxicava arctica Linné, C.
Panopea floridana Heilprin, C, S, A.
Panopea floridana var. navicula Heilprin, C, S.
*Gastrochæna cuneiformis Spengler, C, S.
*Barnea (Scobina) costata Linné, C.
Discinisca lugubris Conrad, C, S, A.

PLIOCENE OF THE CAROLINAS.

Since the Pliocene of the Waccamaw district in South Carolina and the Croatan beds of North Carolina has already been fully discussed (Part II., pp. 201-217, 1892) there seems to be no occasion for repeating the discussion here. The conclusions arrived at at that time have not been in any way invalidated by subsequent researches, and the only changes which might be made are trifling modifications of the nomenclature and arrangement of the lists of species.

PLEISTOCENE OF NORTH CREEK.

Near the settlement of Osprey, on Little Sarasota Bay, Manatee County, on the west coast of Florida, a small stream called North Creek empties into the bay, its banks raised only a few feet above the level of high tide. Here Mr. Willcox discovered a Post-Pliocene deposit from which he, and later the writer also, collected quite a number of species. But little time was spent upon this stratum, and doubtless a good many more species might have been found with more extended search. As an example of what the Pleistocene beds of the peninsula contain, however, even this incomplete series has a certain interest, and it was thought well to include a list of the shells.

The stratum is nearly horizontal and appeared to be less than three feet in thickness. It was chiefly composed of sand darkened by decayed vegetable matter, and the action of the stream had mixed with the material fallen from the low bank bits of pottery from a prehistoric kitchen-midden at no great distance. The house of Judge Webb, at Osprey, is situated on an artificial Indian mound which forms the highest land in the vicinity and is of prehistoric origin. Not far from this locality human remains completely replaced by limonite, in the state of perfect pseudomorphs of the calvarium and other bones of the skeleton, were found by Judge Webb in a stratum of sandstone, where they were uncovered in digging a ditch. Later other specimens of the same character were discovered by Mr. Willcox and Professor Heilprin, and all are described in these Transactions, Volume II., pp. 9-12, in 1889, by the late Dr. Joseph Leidy. They are probably of Pleistocene age.

LIST OF SPECIES COLLECTED AT NORTH CREEK.

The larger and more common species were identified by Mr. C. W. Johnson, of the Wagner Institute, the others by the writer. All the species are found at the present time living on the coast, except a few which are indicated by prefixing an asterisk to their names.

Bulla striata Bruguière.
Tornatina canaliculata Say.
Terebra (Oxymeris) concava Say.
Terebra (Oxymeris) protexta Conrad.
Terebra (Oxymeris) dislocata Say.
Conus pygmæus Reeve.
Mangilia plicosa Adams.
Mangilia cerinella Dall.
Olivella mutica Say.
Marginella apicina Menke.
Marginella minuta Pfeiffer.
Fasciolaria gigantea Kiener.
Fasciolaria distans Lamarck.
Fasciolaria tulipa Linné.
Melongena corona Gmelin.
Busycon perversum Linné.
Busycon pyrum Dillwyn.
Tritonidea tincta Conrad.

Nassa vibex Say.
Anachis avara Say.
Astyris lunata Say.
Urosalpinx perrugatus Conrad.
Urosalpinx tampaënsis Conrad.
Scala Frielei Dall.
Pyramidella (Longchæus) crenulata Holmes.
Eulimella sp.
*Turbonilla (Pyrgiscus) sp.
*Turbonilla (Strioturbonilla) sp.
Odostomia (Heida) caloosaënsis Dall (as Syrnola).
*Odostomia (Scalenostoma) sp.
Odostomia sp. (cf. conoidea Brocchi).
Strombus pugilis Linné.
Cerithium muscarum Say.
*Rissoa (Onoba) callistrophia Dall, var.
Crepidula convexa Say.
Crepidula plana Say.
Natica pusilla Say.
Polynices (Neverita) duplicata Say.
Teinostoma cryptospira Verrill.
Acanthochites spiculosus Reeve.
Arca secticostata Reeve.
Arca transversa Say.
Ostrea virginica Gmelin.
Pecten gibbus var. dislocatus Say.
Pecten gibbus var. irradians Lam.
Modiolus demissus Dillwyn.
Cardita domingensis Orbigny.
Carditamera floridana Conrad.
*Sportella (Fabella) constricta Conrad.
Phacoides pectinatus Gmelin.
Phacoides muricatus Spengler.
Phacoides multilineatus Tuomey and Holmes.
Phacoides floridanus Conrad.
Cardium isocardia Linné.
Cardium robustum Solander.
Lævicardium Mortoni Conrad.
Dosinia discus Reeve.
Dosinia elegans Conrad.
Transennella Conradina Dall.
Macrocallista nimbosa Solander.
Chione cancellata Linné.
Anomalocardia brasiliana Gmelin.
Venus campechiensis Gmelin.
Gemma gemma var. purpurea Lea.
Parastarte triquetra Conrad.
Angulus versicolor Cozzens.
Angulus sybariticus Dall.
Tagelus divisus Spengler.
Labiosa canaliculata Say.
Mulinia lateralis Say.
Mulinia lateralis var. corbuloides Reeve.
Ervilia concentrica Gould.

The total comprises seventy-one species, of which five are extinct as far as known. It is quite probable that by thorough and extended collecting at this locality the number might be increased.

EXPLANATION OF TABLE I.

This table contains in the left hand column the names of the formations, preceded by a capital letter in descending order. There are nineteen formations mentioned, and the first nineteen columns to the right, surmounted by a capital letter, represent the same formations vertically as do the horizontal lines across the table which follow the name of the formation. The figures entered in these columns indicate the number of species found common to the formation and to the other formation by which in the table it is

TABLE I.—STATISTICS OF THE FOSSIL MOLLUSK-FAUNAS DISCUSSED IN THIS WORK.

		S	R	Q	P	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A	Recent	Peculiar	Total	Recent per cent.	Peculiar per cent.	Normal fauna	Fossil fauna per cent.
Pliocene. P.-Pl.	A, North Creek	...	...	...	...	...	8	...	...	6	4	1	13	11	28	2	13	28	24	71	67	3	71	94	4	230	31
	B, Croatan	...	...	...	...	...	5	...	...	...	4	...	5	9	60	2	31	63	96	(71)	80	4	96	83	4	105	91
	C, Waccamaw	...	...	...	...	...	5	...	...	...	4	1	5	23	62	2	71	180	63	(116)	125	15	180	70	8	230	78
	D, Caloosa	1	1	4	1	...	11	...	2	13	19	8	5	32	94	2	639	71	31	13	314	256	639	49	40	650	98
Miocene.	E, Pascagoula	...	...	...	...	...	...	...	...	...	...	...	...	...	1	14	2	2	2	2	2	...	14	...	...	...	....
	F, Duplin	3	2	3	2	2	7	...	1	3	18	7	8	53	331	1	94	62	60	28	68	104	331	20	31	350	94
	G, Chesapeake	...	...	1	1	1	2	...	...	3	5	3	2	135	53	0	32	23	9	11	19	43	135	14	32	136	100
	H, Shiloh	...	...	2	...	...	6	...	...	1	5	5	100	2	8	2	5	5	5	13	13	40	100	13	40	...	....
Oligocene.	I, Oak Grove	...	2	4	1	1	19	...	4	15	81	239	5	3	16	...	8	1	...	1	10	132	239	4	55	230	100
	J, Chipola	2	5	10	4	11	39	1	3	16	333	81	5	5	18	...	19	4	4	4	35	175	333	10	53	483	69
	K, Bowden	1	...	4	...	6	10	...	6	435	16	15	1	3	3	...	13	(6)	...	6	53	287	435	12	66	550	79
	L, Orbitolite	1	2	9	4	...	17	14	58	6	3	4	...	...	1	...	2	...	...	.....	2	10	94	35	...	...	....
	M, Jacksonboro'	2	2	2	...	4	1	44	14	...	1	...	...	...	...	...	...	...	...	.....	...	10	44	...	...	...	....
	N, Tampa silex	3	2	9	11	9	193	1	17	10	39	19	6	2	7	0	11	5	5	8	15	94	193	8	50	230	84
	O, White Beach	...	...	1	...	39	9	4	...	6	11	1	...	1	2	..	...	...	...	.....	4	2	39	...	...	...	....
	P, Ocala limestone	2	2	15	59	...	11	...	4	...	4	1	...	1	2	...	1	...	...	.....	1	26	59	2	42	...	....
	Q, Vicksburgian	3	10	122	15	1	9	2	9	4	10	4	2	1	3	1	4	...	...	.....	2	102	122	2	84	230	53
Eocene.	R, Jacksonian	1	74	10	2	...	2	...	...	...	5	2	...	2	2	..	1	...	...	.....	2	67	74	3	90	230	32
	S, Earlier Eocene	1	...	3	2	...	3	...	...	...	2	...	...	2	3	...	1	...	...	.....	...	...	...	...	...	...	....

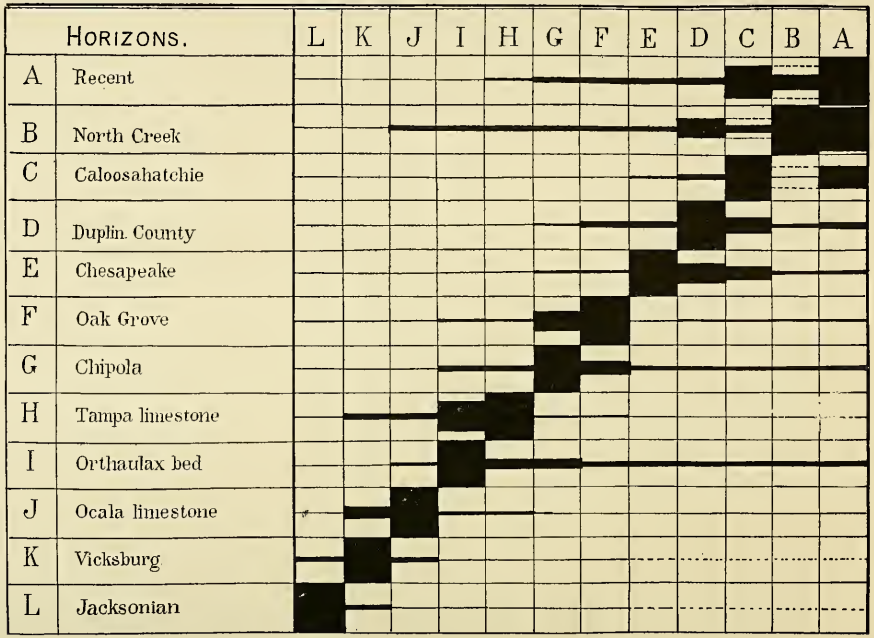
vertically intersected. Where the vertical and horizontal columns of a single formation intersect the figures indicate the total number of species known from that formation. Thus in horizontal column F (Duplin Miocene), at the intersection of vertical column J, we find the number 18, which signifies that there are eighteen Duplin species also found in the Chipola (J) Oligocene. Column S is merely approximate, the required data to make it complete being inaccessible at present. Where no common species are known the vacancy in the intersection indicates the fact, but it must not be inferred that some may not eventually be found common to the two formations. In the column headed "Recent" the number of species now known to survive in each horizon is entered. The next column shows the number of species now known only from that formation, numbers which future researches must inevitably add to. The next two columns give the "Recent" and "Peculiar" species in percentages of the total fauna of the formation to the nearest integer. In Bulletin 84 of the United States Geological Survey (pp. 25–31) I have discussed the question of the number of shell-bearing species of mollusks which is normal to any one limited region. An actual count of the species found in less than one hundred fathoms on the coast of the United States between Cape Hatteras, North Carolina, and the mouth of the Savannah River affords the number of five hundred species. But in any one limited locality, as a sand beach, a rocky shore, an estuary or a lagoon, no one could find all these species. Certain kinds of terrain are more favorable to shells than others; an oyster-reef or a sand beach will always have less population than a shore of mixed mud and gravel. So I have in the column headed "Normal Fauna" given the best estimate that I could of the number of species which might be expected to occur in the locality where collections had been made to illustrate the particular formation referred to. The last column of the Table, headed "Fossil faunas per cent.," shows the percentage which the forms actually found bear to the numbers theoretically probable. If the reasoning is correct, we can expect to find few if any more species than have already been collected in at least five out of the twelve formations so indicated, while of the Pleistocene of North Creek only about one-third of the possible species has been obtained. In a general way I believe these figures to be approximately true.

In the vast number of species which have been considered during the construction of this table it is improbable that the figures in every case should be mathematically exact, but it is probable that the errors if corrected would not affect the general conclusions drawn from the table as it stands. In several cases if the numbers were increased it is unlikely that the percentages would be materially affected.

The names given in the table will be familiar to the reader, but it seems worth while to specify that under G the name Chesapeake applies merely to the Floridian Miocene and does not include that of the more northern States. Under Pascagoula our collections include four species. Professor Smith and Mr. Aldrich announce the presence in the clay of ten more, and these have been added, though I have not seen them.

For the Shiloh list I am mainly dependent on Professor Whitfield's monograph with some additions from my own observations. For the Vicksburg and Jackson lists

TABLE II.—RISE, CULMINATION, AND DECLINE OF FLORIDA NEOCENE MOLLUSK-FAUNAS.



I have similarly used Conrad's checklists and included some but not all of late additions to these faunas.

In the cases of the Croatan and Waccamaw beds, the figures under Column A are taken from the Pleistocene of the Carolinas and not from that of North Creek, Florida. To emphasize this distinction the figures are enclosed in parentheses. The total number of species considered in these statistics is about three thousand one hundred and sixty-two.

Several of the localities have been very imperfectly explored, such as Pascagoula, the Orbitolite bed, Jacksonboro', White Beach, and the Ocala limestone; but a fair number being known, it is probable that the percentages derived from it are not far wrong. I should mention here one factor which makes for usefulness in the figures of the table. Nearly all the collections were made by one man, faithful and devoted to his work, and whose instructions were to be as thorough as possible and take all the time needed. Under these circumstances it is believed that the results are more comparable than those depending on a number of different collectors varying in energy, persistence, and experience.

EXPLANATION OF TABLE II.

This table is intended to present graphically, from a calculation of percentages, the gradual rise, culmination, and decrease of the chief faunas of the Florida series. One exception is made by introducing the Duplin Miocene to take the place of the estuarine Pascagoula, which may perhaps have been contemporaneous with it but is not strictly comparable with a series of marine faunas. The arrangement is essentially as in Table I., but the completely filled black square represents one hundred per cent., and the lesser stripes of black represent the minor percentages as closely as the size of the diagram would permit. In one or two cases the fauna was really continuous, but not wholly continuous in exactly the same locality; so to the black stripe indicating the percentage of local continuity dotted lines are added showing the total continuity. The most marked feature of the indications of the table is the concentration and isolation of most of the faunas. Only in a few instances, and these at the most recent end of the table, do we find any gradual merging of one fauna into another. The most marked and sudden break in the whole table is naturally that which ends the Oak Grove and begins the Chesapeake, which in this case means exclusively the Floridian Miocene. Yet even in the subdivisions of the Oligocene the faunas show in each case where thorough collections have been made about fifty per cent. of species peculiar to each. This is a strong argument in favor of the hypothesis that many other phases, zones, or beds with intermediate faunas remain to be discovered and exploited.

PLATE XLVIII.

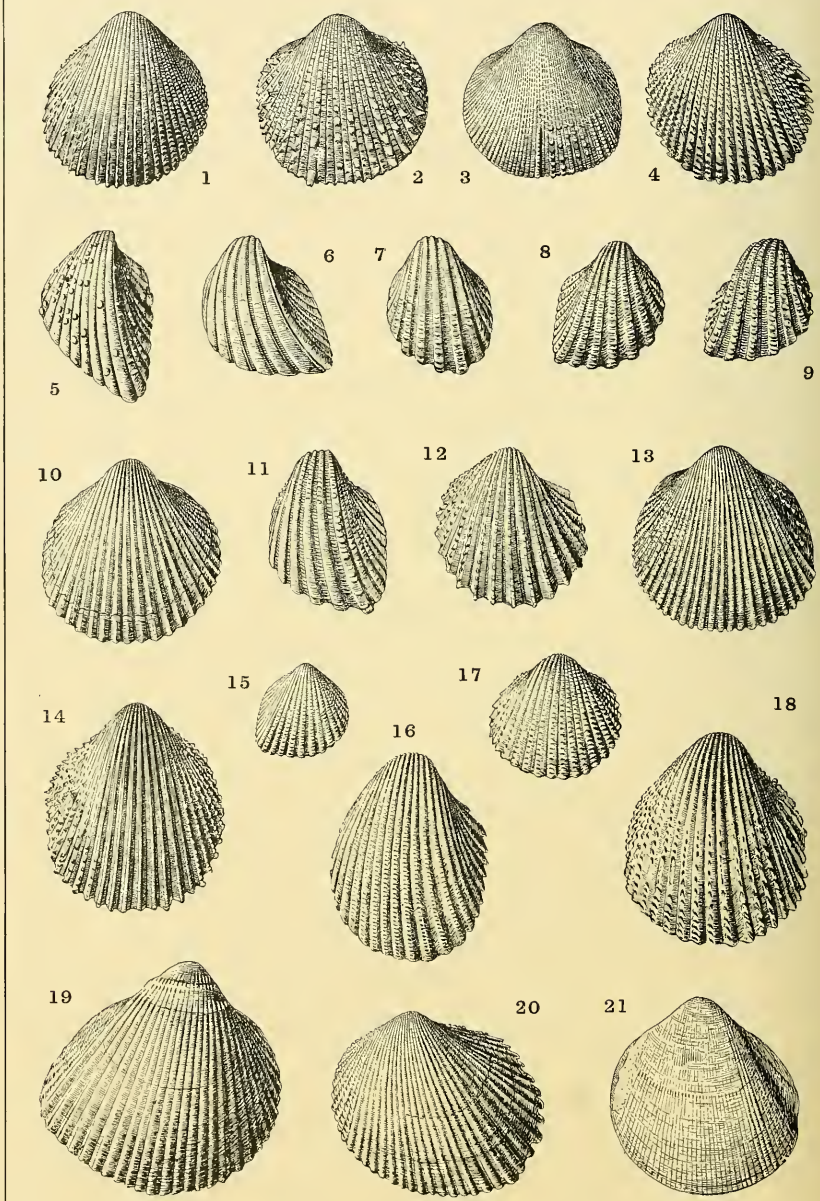


PLATE XLVIII.

Fig. 1. *Cardium virile* Dall; Chipola beds; alt. 28.0 mm.; p. 1086.

Fig. 2. *Cardium acrocome* Dall; Chipola beds; alt. 8.0 mm.; p. 1081.

Fig. 3. *Protocardia jamaicense* Dall; Bowden beds; alt. 6.0 mm.; only a part of the pustulose ornamentation is intact; p. 1114.

Fig. 4. *Cardium malacum* Dall; Oak Grove sands; alt. 25.0 mm.; p. 1087.

Fig. 5. *Cardium alicula* Dall; Chipola beds; alt. 12.0 mm.; only a part of the nodules is intact, if perfect each rib would have a row of them; p. 1103.

Fig. 6. *Cardium apateticum* Dall; Oak Grove sands; alt. 11.0 mm.; this species is normally without nodules; p. 1105.

Fig. 7. *Cardium maturense* Dall; Trinidad; alt. 6.0 mm.; only a part of the nodulation is intact; p. 1105.

Fig. 8. *Cardium Simrothi* Dall; Chipola beds; alt. 8.5 mm.; p. 1104.

Fig. 9. *Cardium Willcoxi* Dall, a young shell with sculpture nearly intact; Caloosahatchie marl; alt. 8.5 mm.; p. 1106.

Fig. 10. *Cardium precursor* Dall; silex beds, Ballast Point, Florida; alt. 22.5 mm.; p. 1086.

Fig. 11. *Cardium aminense* Dall; St. Domingo; alt. 14.0 mm.; p. 1104.

Fig. 12. *Cardium propeciliare* Dall; Chipola beds; alt. 20.0 mm.; p. 1080.

Fig. 13. *Cardium phlyctæna* Dall; Ballast Point silex beds; alt. 27.0 mm.; p. 1097.

Fig. 14. *Cardium cestum* Dall; Chipola beds; alt. 32.0 mm.; p. 1083.

Fig. 15. *Cardium Burnsii* Dall; Chipola beds; alt. 6.5 mm.; p. 1101.

Fig. 16. *Cardium dominicanum* Dall; St. Domingo; alt. 28.0 mm.; p. 1082.

Fig. 17. *Cardium parile* Dall; Chipola beds; alt. 15.0 mm.; p. 1086.

Fig. 18. *Cardium delphicum* Dall; Oak Grove sands; alt. 34.0 mm.; p. 1084.

Fig. 19. *Cardium waltonianum* Dall; alt. 39.0 mm.; p. 1093.

Fig. 20. *Cardium* (*Papyridea*) *bulbosum* Dall; Chipola beds; lon. 27.0 mm.; p. 1109.

Fig. 21. *Cardium* (*Lævicardium*) *compressum* Dall; Chipola beds; alt. 23.0 mm.; p. 1109.

PLATE XLIX.

Fig. 1. *Cardium tæniopleura* Dall; Yorktown Miocene; the greater part of the surface and ribs has been eroded but the fragment is figured to show the general form; lon. 28.0 mm.; p. 1095.

Fig. 2. *Cardium tæniopleura* Dall; part of three ribs enlarged to show the peculiar sculpture.

Fig. 3. *Cardium ædalium* Dall; Caloosahatchie marls; lon. 31.0 mm.; p. 1088.

Fig. 4. *Abra triangulata* Dall; Oligocene of Bowden, Jamaica; lon. 6.25 mm.; p. 997.

Fig. 5. *Tellina* (*Merisca*) *sclera* Dall; Oligocene of Bowden, Jamaica; lon. 4.2 mm.; p. 1021.

Fig. 6. *Metis magnoliana* Dall; Miocene of North Carolina; lon. 71.0 mm.; p. 1042.

Fig. 7. *Macoma Kelseyi* Dall; Pleistocene of California; lon. 86.0 mm.; p. 1052.

Fig. 8. *Cooperella Carpenteri* Dall; Miocene of Virginia; lon. 14.0 mm.; p. 1063.

Fig. 9. *Bornia plectopygia* Dall; Claibornian Eocene of Alabama; lon. 4.5 mm.; p. 1149.

Fig. 10. *Bornia scintillata* Dall; Claibornian Eocene of Alabama; lon. 3.75 mm.; p. 1149.

Fig. 11. *Crassatellites* (*Crassinella*) *tanicus* Dall; Oligocene of Oak Grove, Florida; alt. 3.15 mm.; p. 1477.

Fig. 12. *Crassatellites* (*Scambula*) *chipolanus* Dall; Chipola, Florida, Oligocene; lon. 44.0 mm.; p. 1472.

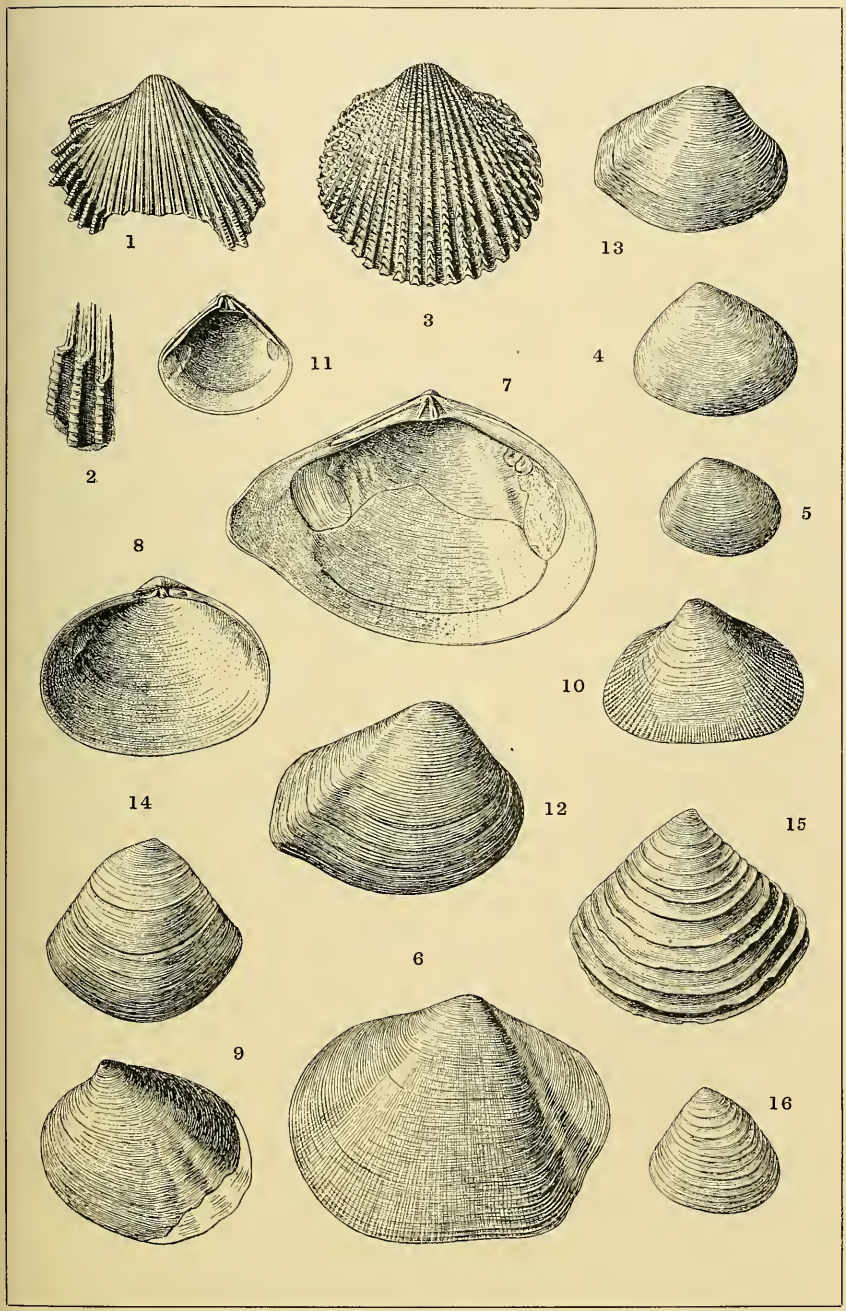
Fig. 13. *Crassatellites* (*Scambula*) *jamaicensis* Dall; Oligocene of Bowden, Jamaica; lon. 49.0 mm.; p. 1471.

Fig. 14. *Crassatellites* (*Crassinella*) *galvestonensis* Harris; Miocene of Yorktown, Virginia; alt. 5.2 mm.; p. 1478.

Fig. 15. *Crassatellites* (*Crassinella*) *lunulatus* Conrad; Miocene of Duplin County, North Carolina; alt. 6.0 mm.; p. 1477.

Fig. 16. *Crassatellites* (*Crassinella*) *triangulatus* Dall; Oligocene of Alum Bluff, Florida; alt. 3.3 mm.; p. 1476.

PLATE XLIX.



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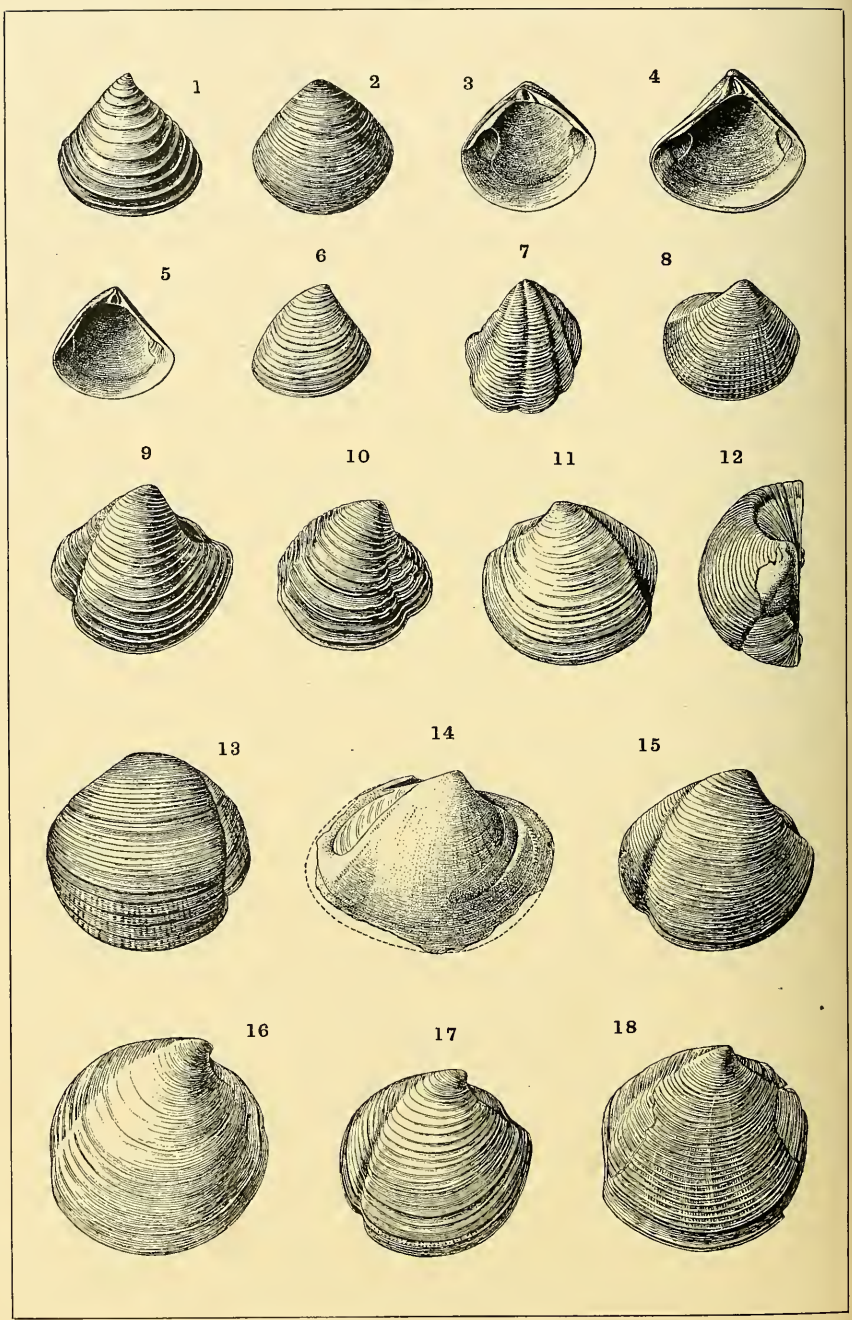


PLATE L.

Fig. 1. *Crassatellites* (*Crassinella*) *ocutus* Dall, exterior of left valve; Pliocene of the Caloosahatchie; alt. 4.0 mm.; p. 1479.

Fig. 2. *Crassatellites* (*Crassinella*) *bowdenensis* Dall, exterior of right valve; Oligocene marl of Bowden, Jamaica; alt. 4.0 mm.; p. 1476.

Fig. 3. The same, interior of left valve; alt. 3.5 mm.; p. 1476.

Fig. 4. *Crassatellites* (*Crassinella*) *acutus* Dall, interior of left valve; alt. 4.0 mm.; p. 1479.

Fig. 5. *Crassatellites* (*Crassinella*) *duplinianus* Dall, interior of right valve; Miocene of Duplin County, North Carolina; alt. 3.22 mm.; p. 1478.

Fig. 6. The same, exterior of left valve; alt. 3.22 mm.; p. 1478.

Fig. 7. *Phacoides* (*Pleurolucina*) *quadricostatus* Dall; Oligocene marl of Bowden, Jamaica; lon. 6.0 mm.; p. 1368.

Fig. 8. *Phacoides* (*Parvilucina*) *intensus* Dall; Pliocene of San Diego, California; lon. 5.0 mm.; p. 1385.

Fig. 9. *Phacoides* (*Here*) *hamatus* Dall; Claibornian Eocene; lon. 14.0 mm.; p. 1364.

Fig. 10. *Phacoides* (*Here*) *tithonis* Dall; Oligocene marl of Bowden, Jamaica; lon. 4.5 mm.; p. 1366.

Fig. 11. *Phacoides domingensis* Dall; Oligocene of the Tampa, Florida, silex beds at Ballast Point; lon. 22.0 mm.; p. 1363.

Fig. 12. *Phacoides* (*Here*) *podagrinus* Dall, umbonal view of left valve; Oligocene marl of Bowden, Jamaica; lon. 29.0 mm.; p. 1365.

Fig. 13. The same, side view of the same valve; p. 1365.

Fig. 14. *Phacoides* (*Miltha*) *ocolanus* Dall, internal cast from the Ocala, Florida, Oligocene limestone; lon. 41.0 mm.; p. 1375.

Fig. 15. *Phacoides* (*Here*) *wacissanus* Dall, exterior of right valve; from the Ballast Point Oligocene silex beds; lon. 16.0 mm.; p. 1365.

Fig. 16. *Phacoides* (*Miltha*) *floridanus* Conrad, from a recent specimen for comparison; lon. 32.0 mm.; p. 1378.

Fig. 17. *Phacoides* (*Here*) *Glenni* Dall; from the Chipola Oligocene; lon. 30.0 mm.; p. 1366.

Fig. 18. *Phacoides* (*Miltha*) *claibornensis* Conrad; from the Eocene of the Claiborne sands of Alabama; lon. 36.0 mm.; p. 1374.

PLATE LI.

Fig. 1. *Divaricella quadrisulcata* Orbigny; from the Miocene of Petersburg, Virginia; lon. 18.5 mm.; p. 1389.

Fig. 2. *Divaricella chipolana* Dall; from the Oligocene bed at Alum Bluff, Florida; lon. 18.5 mm.; p. 1389.

Fig. 3. *Divaricella compsa* Dall; from the Pliocene marl of Shell Creek, Florida; lon. 11.5 mm.; p. 1391.

Fig. 4. *Codakia* (*Jagonia*) *pertenera* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 37.0 mm.; p. 1347.

Fig. 5. *Cyrenoida caloosaënsis* Dall; from the Pliocene marl of the Caloosahatchie River, Florida; lon. 31.0 mm.; p. 1335.

Fig. 6. *Lucina santarosana* Dall; from the uppermost Oligocene sand at Oak Grove, Florida; lon. 39.0 mm.; p. 1354.

Fig. 7. *Lucina corpulenta* Dall; from the Chipola Oligocene, Florida; lon. 42.0 mm.; p. 1354.

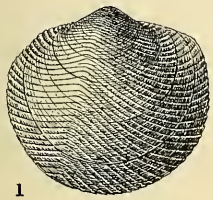
Fig. 8. The same, umbonal view.

Fig. 9. *Lucina janus* Dall; from the Chipola Oligocene, Calhoun County, Florida; lon. 42.0 mm.; p. 1353.

Fig. 10. *Phacoides* (*Miltha*) *heracleus* Dall; from the Chipola Oligocene; lon. 77.0 mm.; p. 1376.

Fig. 11. *Phacoides* (*Miltha*) *chipolanus* Dall, restored from fragments of the opposite valve; from the Chipola Oligocene; lon. 71.0 mm.; p. 1375.

PLATE LI.



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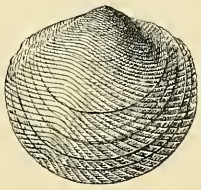

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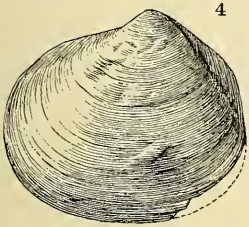

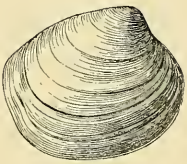

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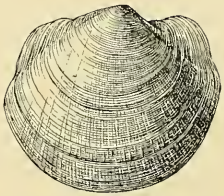

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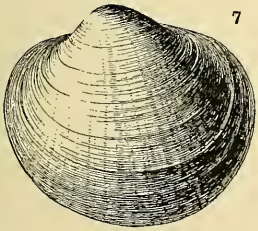

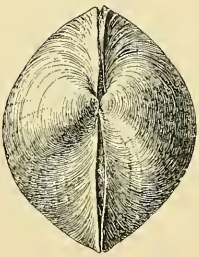

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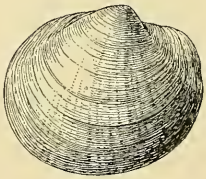

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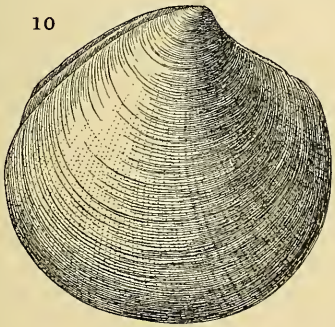

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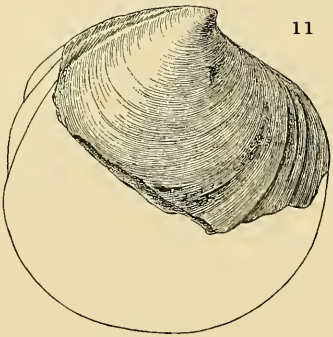


PLATE LII.

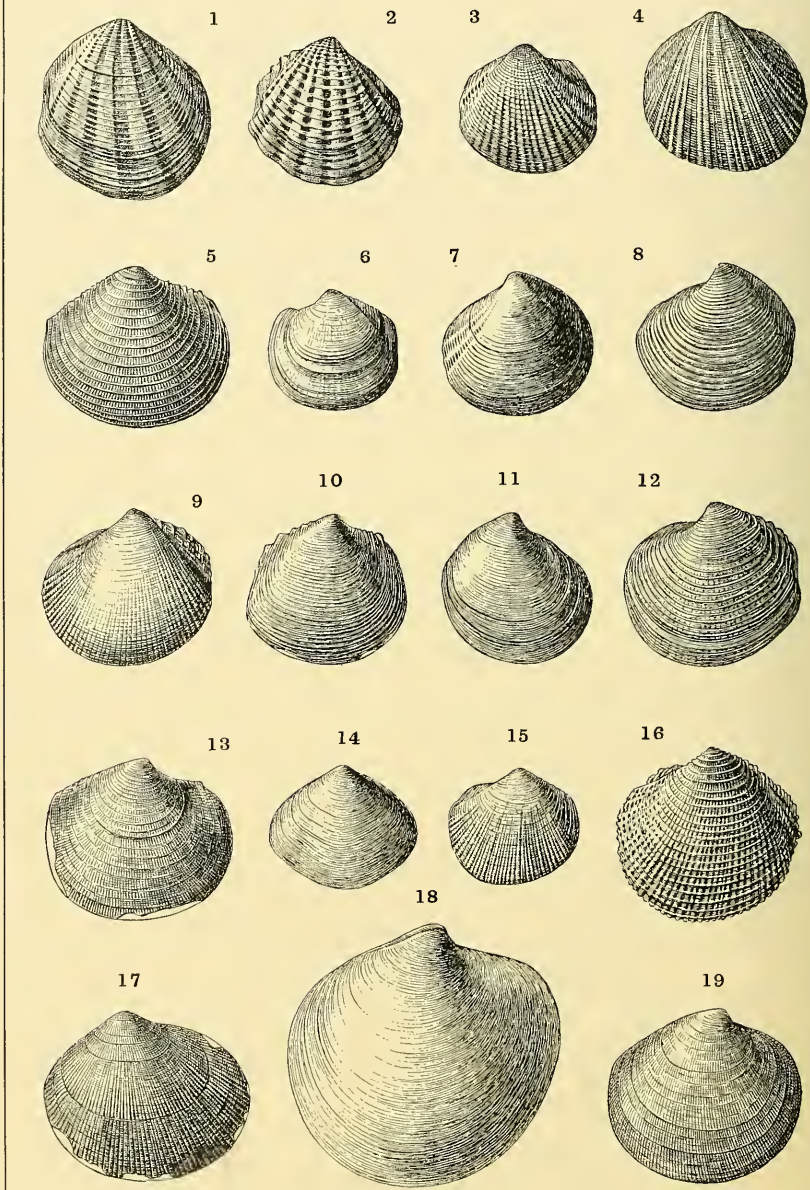


PLATE LII.

Fig. 1. *Phacoides* (*Bellucina*) *Tuomeyi* Dall; from the Miocene of Duplin County, North Carolina; lon. 7.5 mm.; p. 1385.

Fig. 2. *Phacoides* (*Bellucina*) *waccamawensis* Dall; from the Pliocene of the Waccamaw district, South Carolina; lon. 6.3 mm.; p. 1386.

Fig. 3. *Phacoides* (*Bellucina*) *actinus* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 4.6 mm.; p. 1385.

Fig. 4. *Codakia* (*Jagonia*) *Vendryesi* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 7.5 mm.; p. 1348.

Fig. 5. *Myrtæa* (*Eulopia*) *vermiculata* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 7.5 mm.; p. 1359.

Fig. 6. *Phacoides* (*Parvilucina*) *piluliformis* Dall; from the Oligocene sand of Oak Grove, Florida; lon. 4.5 mm.; p. 1382.

Fig. 7. *Codakia* (*Jagonia*) *erosa* Dall; from the Chipola Oligocene; lon. 7.0 mm.; p. 1348.

Fig. 8. *Phacoides* (*Parvilucina*) *prunus* Dall; from the Miocene of Plum Point, Maryland; lon. 7.0 mm.; p. 1384.

Fig. 9. *Codakia* (*Jagonia*) *chipolana* Dall; from the Chipola Oligocene; lon. 8.2 mm.; p. 1349.

Fig. 10. *Myrtæa limoniana* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 9.0 mm.; p. 1358.

Fig. 11. *Phacoides* (*Cavilucina*) *recurrens* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 5.7 mm.; p. 1369.

Fig. 12. *Phacoides* (*Parvilucina*) *crenulatus* Conrad; from the upper Miocene of Suffolk, Virginia; lon. 6.5 mm.; p. 1383.

Fig. 13. *Myrtæa* (*Eulopia*) *furcata* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 13.0 mm.; p. 1359.

Fig. 14. *Grateloupia alumensis* Dall; from the Oligocene horizon at Alum Bluff, Florida; lon. 15.0 mm.; p. 1239.

Fig. 15. *Phacoides* (*Parvilucina*) *sphæriolus* Dall; from the Chipola, Florida, Oligocene; lon. 4.25 mm.; p. 1382.

Fig. 16. *Phacoides* (*Lucinisca*) *calhounensis* Dall; from the Chipola, Florida, Oligocene; lon. 10.0 mm.; p. 1371.

Fig. 17. *Codakia* (*Jagonia*) *magnoliana* Dall; from the Miocene of Magnolia, Duplin County, North Carolina; lon. 11.5 mm.; p. 1349.

Fig. 18. *Cyclinella gatunensis* Dall; from the Oligocene beds at Gatun, Panama; lon. 43.0 mm.; p. 1285.

Fig. 19. *Codakia spinulosa* Dall; from the Oligocene marl of Bowden, Jamaica; lon. 29.0 mm.; p. 1346.

PLATE LIII.

Fig. 1. Hinge of very young *Chama pellucida* Conrad; from San Pedro, California; the valve 2.0 mm. long, much magnified, drawn with camera lucida by W. H. Dall; *card.*, cardinal teeth; *lat.*, lateral laminæ; *lig.*, ligament; p. 1394.

Fig. 2. Hinge of *Erycinella ovalis* Conrad, much enlarged and drawn with camera lucida by W. H. Dall; *c.c.*, cardinals; *res.*, resiliary pit; *lig.*, ligamentary groove; p. 1438.

Fig. 3. *Cytherea Willcoxi* Dall; from the Caloosahatchie marls; lon. 102.0 mm.; p. 1276.

Fig. 4. *Dosinia liogona* Dall, young shell; Oak Grove sands; alt. 4.0 mm.; p. 1230.

Fig. 5. *Cytherea cæsarina* Dall; Chipola Oligocene; lon. 66.0 mm.; p. 1275.

Fig. 6. *Cyathodonta guadelupensis* Dall; Oligocene of Guadeloupe Island, West Indies; lon. 39.0 mm.; p. 1527.

Fig. 7. *Dosinia liogona* Dall, young shell, enlarged to show serrate posterior cardinal tooth; lon. 4.0 mm.; p. 1230.

Fig. 8. *Cyathodonta Spenceri* Dall; Oligocene of Guadeloupe Island, West Indies; lon. 45.0 mm.; p. 1527.

Fig. 9. *Venericardia nasuta* Dall; Eocene of Alabama; lon. 41.0 mm.; p. 1425.

Fig. 10. *Carditopsis Bernardi* Dall, camera lucida drawing; Pliocene of Costa Rica; lat. 2.2 mm.; p. 1438.

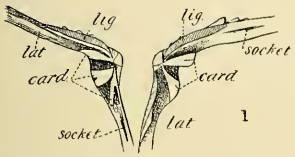
Fig. 11. *Venericardia hadra* Dall; Chipola Oligocene; lat. 40.0 mm.; p. 1429.

Fig. 12. *Venericardia himerta* Dall; uppermost Oligocene of Oak Grove, Florida; lon. 55.0 mm.; p. 1430.

Fig. 13. *Venericardia hadra* Dall, dorsal view; lon. 40.0 mm.; p. 1429.

Fig. 14. *Cardita (Carditamera) Prestoni* Dall, internal cast; Miocene of Florida; lon. 58.0 mm.; p. 1415.

PLATE LIII.



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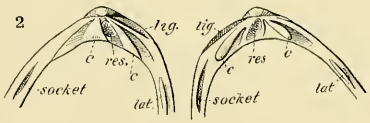

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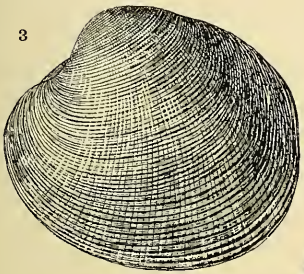

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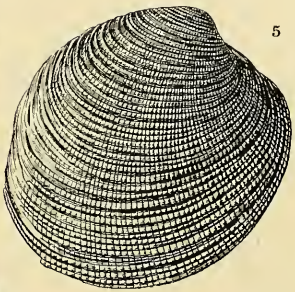

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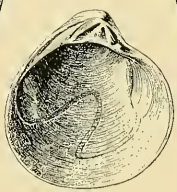

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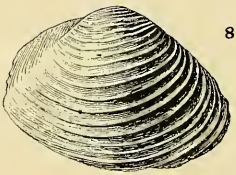

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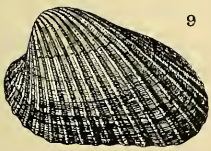

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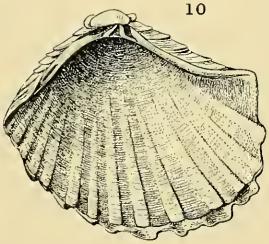

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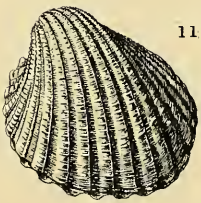

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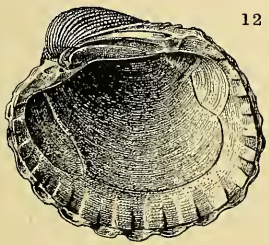

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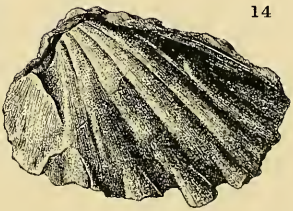

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PLATE LIV.

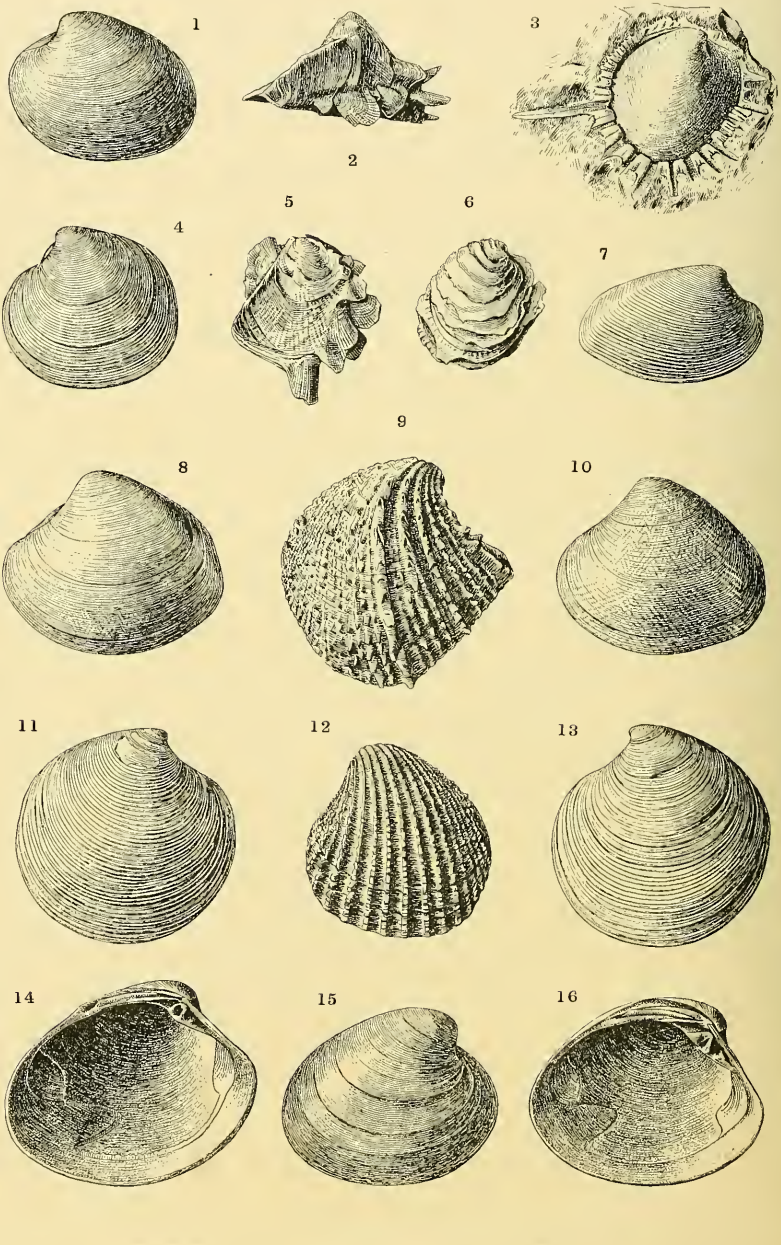

PLATE LIV.

Fig. 1. *Callocardia gatunensis* Dall; Gatun beds, Isthmus of Panama; lon. 38.0 mm.; p. 1260.

Fig. 2. *Chama caloosana* Dall, attached valve; Pliocene of Florida; lat. 40.0 mm.; p. 1402.

Fig. 3. *Chama Lyelli* Dall, cast from Oligocene limestone of Jacksonboro', Georgia, showing long spines; lat., exclusive of spines, 20.0 mm.; p. 1399.

Fig. 4. *Dosinia chipolana* Dall; Chipola Oligocene; lat. 40.0 mm.; p. 1229.

Fig. 5. *Chama caloosana* Dall, exterior of upper valve; lat. 23.0 mm.; p. 1402.

Fig. 6. *Chama tampaënsis* Dall, upper valve; Oligocene silex beds of Tampa, Florida; lat. 20.0 mm.; p. 1398.

Fig. 7. *Pitaria Hilli* Dall; Gatun beds, Isthmus of Panama; lon. 36.0 mm.; p. 1268.

Fig. 8. *Pitaria opisthogrammata* Dall; Pliocene of Florida; lon. 32.0 mm.; p. 1267.

Fig. 9. *Echinochama antiquata* Dall; Oligocene of the Bowden, Jamaica, marl; lon. 45.0 mm.; p. 1404.

Fig. 10. *Pitaria floridana* Dall; Chipola Oligocene; lon. 30.0 mm.; p. 1267.

Fig. 11. *Dosinia liogona* Dall, adult shell; uppermost Oligocene of Oak Grove, Florida; lon. 48.0 mm.; p. 1230.

Fig. 12. *Venericardia wilcoxensis* Dall; Midway Eocene of Matthews Landing, Alabama; lon. 36.0 mm.; p. 1426.

Fig. 13. *Dosinia acetabulum* var. *obliqua* Dall; Miocene; alt. 49.0 mm.; p. 1231.

Fig. 14. *Callocardia morrhuana* Linsley; recent for comparison with *C. Sayana* Conrad; lon. 49.0 mm.; p. 1262.

Fig. 15. *Callocardia gatunensis* var. *multifilosa* Dall; Oligocene of the Isthmus of Panama; lon. 38.0 mm.; p. 1261.

Fig. 16. *Callocardia Sayana* Conrad; Miocene of York River, Virginia; lon. 45.0 mm.; p. 1261.

PLATE LV.

Fig. 1. *Anomalocardia chipolana* Dall; Chipola Oligocene; lon. 6.5 mm.; p. 1304.

Fig. 2. *Chione* (*Chamelea*) *craspedonia* Dall; Vicksburgian Oligocene, Vicksburg, Mississippi; lon. 28.0 mm.; p. 1300.

Fig. 3. *Subemarginula retiporosa* Dall; Pliocene marl of Shell Creek, Florida; lon. 13.0 mm.; see also Plate 60, Fig. 17.

Fig. 4. *Transennella carolinensis* Dall; Miocene of Duplin County, North Carolina; lon. 11.0 mm.; p. 1242.

Fig. 5. *Chione erosa* Dall; Miocene of Florida; lon. 35.0 mm.; p. 1290.

Fig. 6. *Crepidula æsop* Dall, dorsal view; Pliocene marl of Shell Creek, Florida; lon. 6.5 mm.; p. 1610.

Fig. 7. The same, side view.

Fig. 8. *Chione erosa* Dall, internal view showing obsolescence of the pallial sinus; Miocene of Florida; p. 1290.

Fig. 9. *Chione* (*Chamelea*) *nuciformis* Heilprin; Oligocene silex beds of Tampa, Florida; lon. 24.0 mm.; p. 1300.

Fig. 10. *Chione* (*Chamelea*) *rhodia* Dall; Oligocene silex beds of Tampa, Florida; lon. 18.0 mm.; p. 1301.

Fig. 11. *Anomalocardia dupliniana* Dall; Miocene of Duplin County, North Carolina; lon. 5.0 mm.; p. 1305.

Fig. 12. *Callocardia sincera* Dall; Chipola Oligocene; lon. 20.5 mm.; p. 1260.

Fig. 13. *Chione* (*Chamelea*) *spada* Dall; Oligocene silex beds of Tampa, Florida; lon. 29.0 mm.; p. 1301.

Fig. 14. *Anomalocardia floridana* Conrad, dorsal view; Tampa silex beds; lon. 38.0 mm.; p. 1303.

Fig. 15. The same, side view.

Fig. 16. *Cytherea* (*Artena*) *Shepardi* Dall; Tampa silex beds; lon. 21.0 mm.; p. 1278.

Fig. 17. *Chione* (*Lirophora*) *victoria* Dall; Oligocene of Vicksburg, Mississippi; lon. 24.5 mm.; p. 1293.

Fig. 18. *Chione* (*Lirophora*) *xesta* Dall; Miocene of Alum Bluff, Florida; lon 30.0 mm.; p. 1297.

Fig. 19. *Pitaria calcanea* Dall; Oligocene of Vicksburg, Mississippi; lon. 17.0 mm.; p. 1270.

Fig. 20. *Chione chipolana* Dall; Chipola Oligocene; lon. 32.0 mm.; p. 1290.

Fig. 21. *Chione* (*Lirophora*) *glyptocyma* Dall; Oak Grove sands; lon. 33.0 mm.; p. 1296.

Fig. 22. *Chione* (*Lirophora*) *Hendersoni* Dall; Bowden marl of Jamaica, West Indies; lon. 27.5 mm.; p. 1295.

Fig 23. *Chione* (*Lirophora*) *ballista* Dall; Tampa silex beds; lon. 24.0 mm.; p. 1295.

Fig. 24. *Cytherea* (*Artena*) *glyptoconcha* Dall; Tampa silex beds; lon. 26.5 mm.; p. 1277.

PLATE LV.

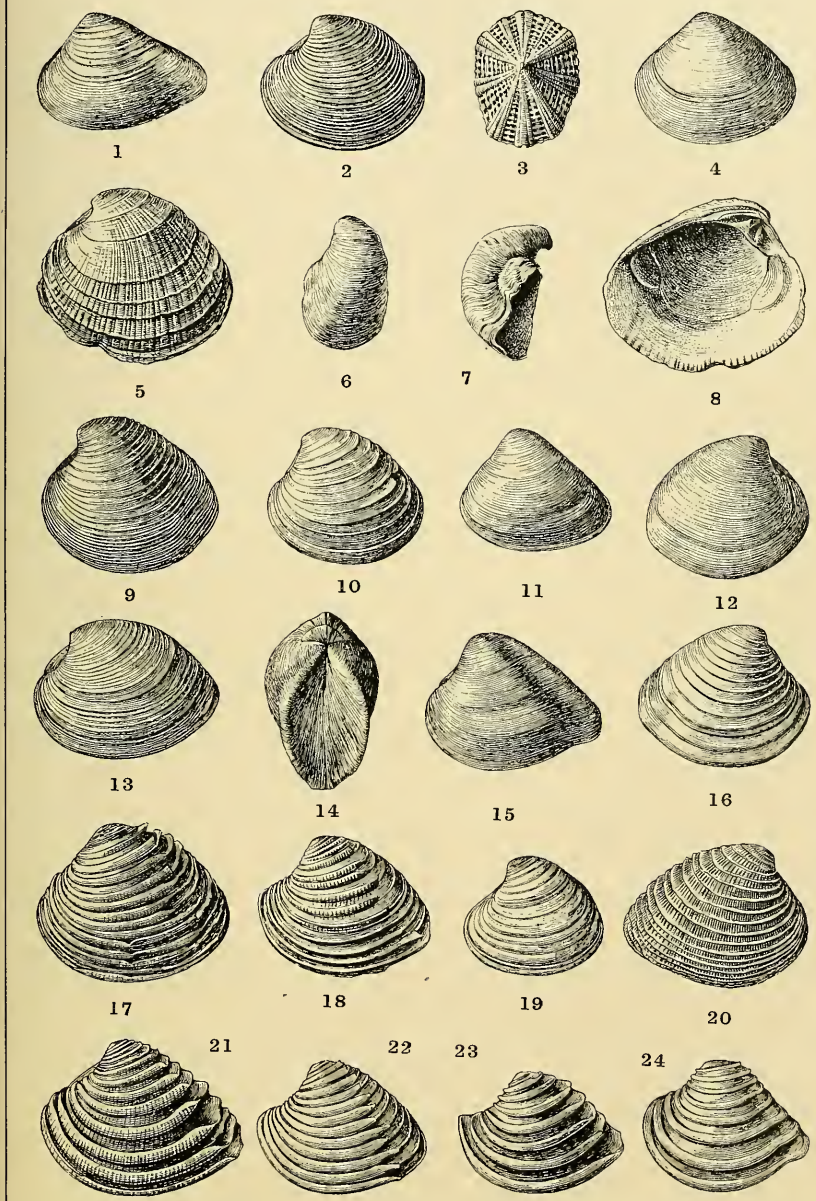

PLATE LVI.

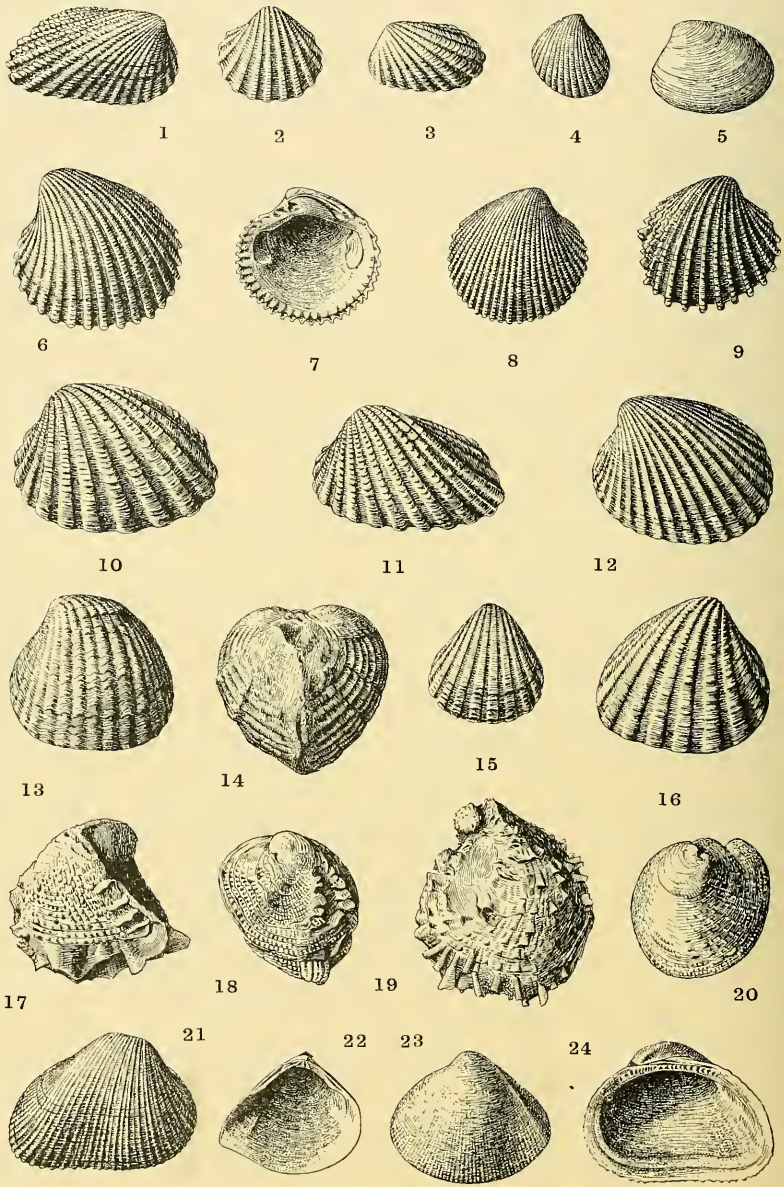

PLATE LVI.

Fig. 1. *Cardita* (*Carditamera*) *catharia* Dall; Caloosahatchie Pliocene of Florida; lon. 7.5 mm.; p. 1416.

Fig. 2. *Venericardia* (*Pleuromeris*) *tellia* Dall; Chipola Oligocene; lon. 3.5 mm.; p. 1432.

Fig. 3. *Cardita* (*Carditamera*) *Guppyi* Dall; Pliocene of Trinidad, West Indies; lon. 4.0 mm.; p. 1413.

Fig. 4. *Venericardia* (*Pteromeris*) *acaris* Dall; Oligocene marl of Bowden, Jamaica; lon. 2.5 mm.; p. 1434.

Fig. 5. *Goadallia americana* Dall; Claiborne sands; lon. 4.25 mm.; p. 1496.

Fig. 6. *Venericardia vicksburgiana* Dall; Vicksburgian Oligocene of Martin, Florida; lon. 16.0 mm.; p. 1428.

Fig. 7. *Venericardia præcisa* Dall; Jacksonian Eocene of Cleveland County, Arkansas; lon. 13.2 mm.; p. 1427.

Fig. 8. The same.

Fig. 9. *Venericardia carsonensis* Dall; Eocene of Carson's Creek; lon. 13.0 mm.; p. 1427.

Fig. 10. *Cardita* (*Carditamera*) *Vaughani* Dall; Miocene of Jackson Bluff, Florida; lon. 35.0 mm.; p. 1410.

Fig. 11. *Cardita* (*Carditamera*) *floridana* Conrad; recent, figured for comparison; Florida; lon. 32.0 mm.; p. 1415.

Fig. 12. *Venericardia simplex* Dall; Wood's Bluff Eocene; lon. 18.0 mm.; p. 1426.

Fig. 13. *Venericardia bulla* Dall; Midwayan Eocene of Texas; lon. 22.0 mm.; lat. 33.0 mm.; p. 1424.

Fig. 14. The same.

Fig. 15. *Venericardia* (*Pleuromeris*) *scitula* Dall; Oak Grove sands; lon. 5.0 mm.; p. 1433.

Fig. 16. *Venericardia* (*Cyclacardia*) *californica* Dall; Miocene of Guadalupe, California; lon. 24.0 mm.; p. 1431.

Fig. 17. *Chama draconis* Dall, attached valve; Chipola Oligocene; lon. 26.0 mm.; p. 1399.

Fig. 18. *Chama draconis* Dall, upper valve; lon. 22.0 mm.; p. 1399.

Fig. 19. *Chama chipalana* Dall, attached valve; Chipola Oligocene; lon. 27.0 mm.; p. 1398.

Fig. 20. The same, upper valve; lon. 22.0 mm.

Fig. 21. *Arca* (*Acar*) *millifila* Dall; Pliocene of Shell Creek, Florida; lon. 18.5; diam. 10.0 mm.

Fig. 22. *Cyrena* (*Pseudacyrena*) *dupliniana* Dall; Miocene of Duplin County, North Carolina; lon. 8.5 mm.; p. 1446.

Fig. 23. *Paromya jamaicensis* Dall; Oligocene of the Bowden, Jamaica, marl; lon. 5.5 mm.; p. 1509.

Fig. 24. *Arca* (*Acar*) *millifila* Dall; Pliocene marl of Shell Creek, Florida; the ligament is typical of Acar, the radial threads are minutely granular, especially on the posterior dorsal slope; the shell is thin and the scars obscure.

PLATE LVII.

Fig. 1. *Pitaria filosina* Dall; Miocene of Duplin County, North Carolina; lon. 7.75 mm.; p. 1270.

Fig. 2. *Transennella caloosana* Dall; Pliocene marl of the Caloosahatchie, Florida; lon. 13.5 mm.; p. 1242.

Fig. 3. *Macrocallista acuminata* Dall; Chipola Oligocene; lon. 28.0 mm.; p. 1255.

Fig. 4. *Gemma magna* Dall; Miocene of Duplin County, North Carolina; lon. 7.0 mm.; p. 1330.

Fig. 5. *Gouldia alta* Dall; Oak Grove sands; lon. 4.5 mm.; p. 1249.

Fig. 6. *Transennella chipolana* Dall; Chipola Oligocene; lon. 5.0 mm.; p. 1241.

Fig. 7. *Anomalocardia bowdeniana* Dall; Oligocene marls of Bowden, Jamaica; lon. 4.5 mm.; p. 1304.

Fig. 8. *Gemma trigona* Dall; Miocene of Duplin County, North Carolina; lon. 4.25 mm.; p. 1330.

Fig. 9. *Tivela jamaicensis* Dall; Oligocene marl of Bowden, Jamaica; lon. 6.0 mm.; p. 1244.

Fig. 10. *Gouldia erosa* Dall; Chipola Oligocene; lon. 8.3 mm.; p. 1248.

Fig. 11. *Astarte opulentora* Dall; Pliocene of Tehuantepec; lon. 11.0 mm.; p. 1494.

Fig. 12. *Transennella utica* Dall; Chipola Oligocene; lon. 7.0 mm.; p. 1240.

Fig. 13. *Transennella santarosana* Dall; Oak Grove sands; lon. 6.5 mm.; p. 1241.

Fig. 14. *Cytherea ucuttana* Dall; Red Bluff Eocene at Ucutta Creek; lon. 19.0 mm.; p. 1276.

Fig. 15. *Periploma angulifera* Philippi; Pliocene of Shell Creek, Florida; lon. 21.0 mm.; p. 1529.

Fig. 16. *Cuspidaria* (*Bowdenia*) *distira* Dall; Oligocene marl of Bowden, Jamaica; lon. 3.0 mm.; p. 1506.

Fig. 17. *Cuspidaria* (*Cardiomya*) *craspedonia* Dall; Bowden marl; lon. 4.0 mm.; p. 1506.

Fig. 18. *Pandora* (*Kennerleyia*) *lata* Dall; Miocene, Maryland; lon. 18.5 mm.; p. 1520.

Fig. 19. *Astarte distans* var. *floridana* Dall; Miocene of Alum Bluff, Florida; lon. 26.0 mm.; p. 1493.

Fig. 20. *Astarte Wagneri* Dall; Oak Grove sands; lon. 12.0 mm.; p. 1488.

Fig. 21. *Lirodiscus Wailesii* Dall; Jacksonian; lon. 18.0 mm.; p. 1483.

Fig. 22. *Astarte parma* Dall; Miocene of Maryland; lon. 29.0 mm.; p. 1493.

Fig. 23. *Anisodonta americana* Dall; Pliocene marl of Shell Creek, Florida; lon. 8.5 mm.; p. 1133.

Fig. 24. *Lyonsia acuta* Dall; Pliocene marl of Shell Creek, Florida; lon. 7.5 mm.; p. 1514.

Fig. 25. *Pandora* (*Kennerleyia*) *dodona* Dall; Oak Grove sands, Florida; lon. 12.0 mm.; p. 1518.

Fig. 26. *Pandora* (*Kennerleyia*) *arctica* Dall; Pleistocene clays of Saco, Maine; lon, 16.0 mm.; p. 1520.

Fig. 27. *Cyathodonta vicksburgiana* Dall; Vicksburg, Mississippi; lon. 33.0 mm.; p. 1526.

Fig. 28. *Spheniopsis americana* Dall; Oligocene of the Bowden, Jamaica, marl; lon. 3.0 mm.; p. 1508.

Fig. 29. The same, internal view, showing hinge and pallial sinus.

Fig. 30. *Pleurodesma floridana* Dall; Pliocene marls of Shell Creek, Florida; lon. 14.5 mm.

PLATE LVII.

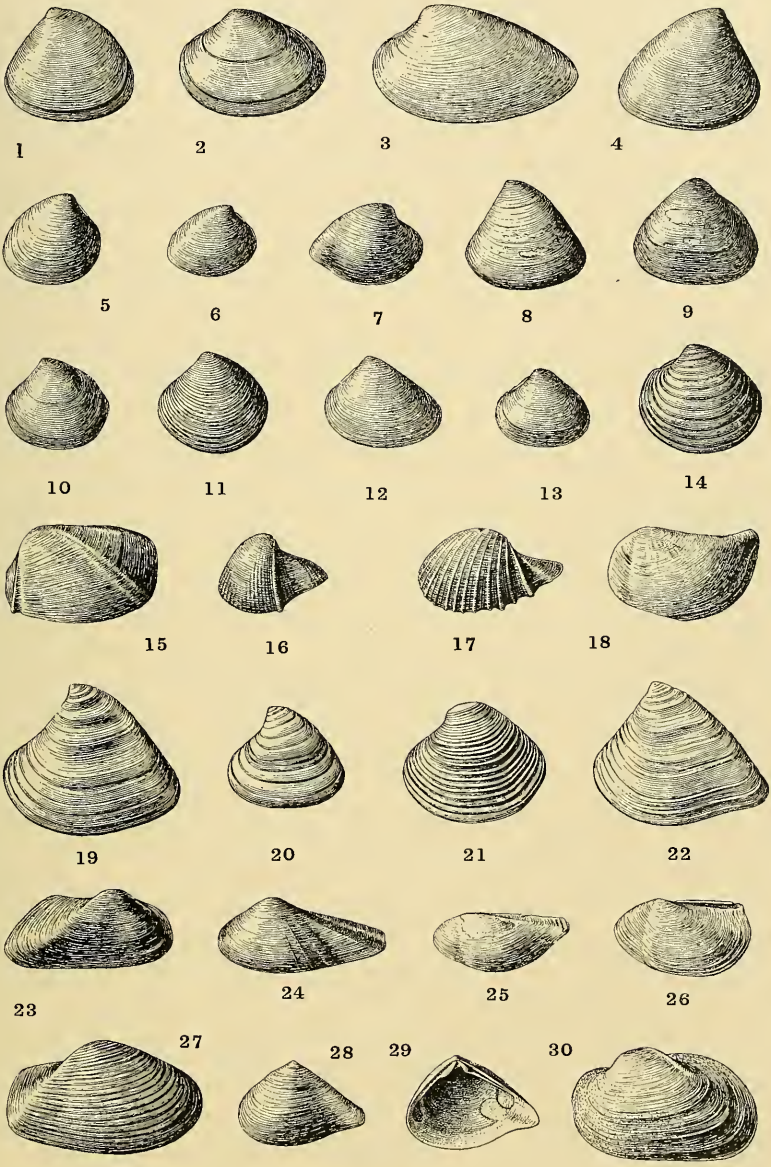
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PLATE LVIII.

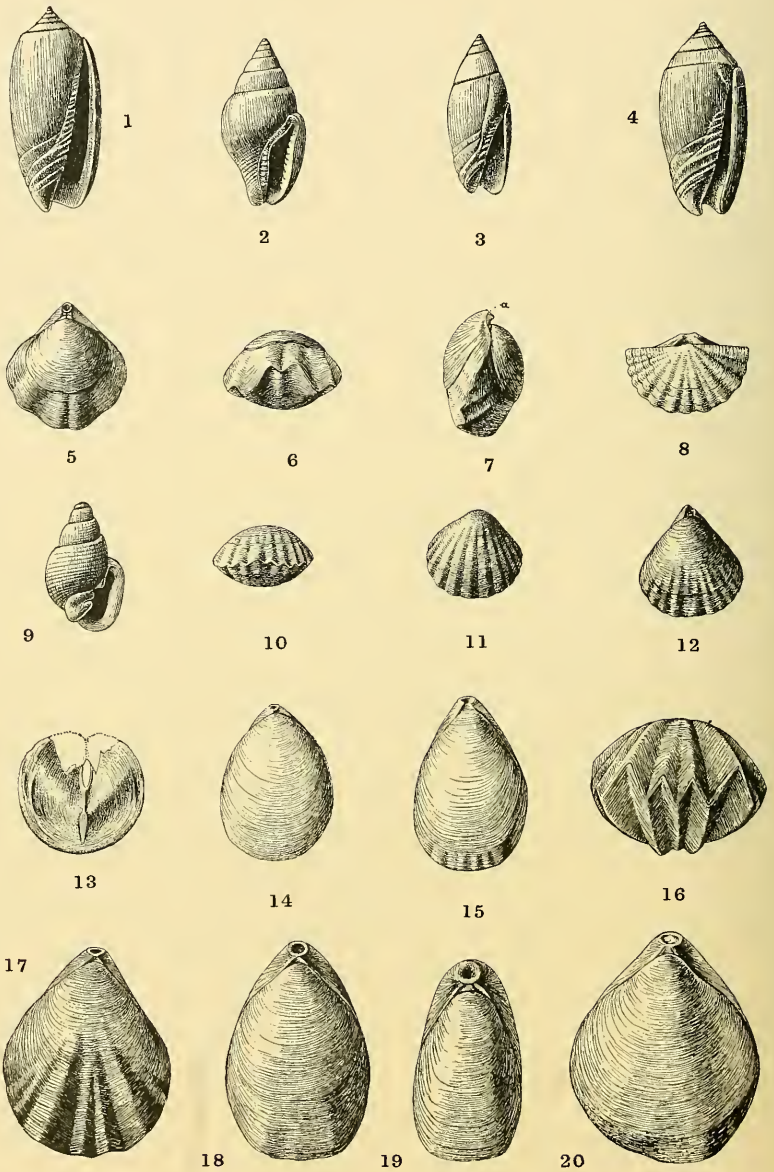

PLATE LVIII.

Fig. 1. *Oliva liodes* Dall; Chipola Oligocene; alt. 27.0 mm.; p. 1576.

Fig. 2. *Columbella cosmia* Dall; Pliocene marl of Shell Creek, Florida; alt. 13.5 mm.; p. 1607.

Fig. 3. *Olivella eutacta* Dall; Chipola Oligocene; alt. 15.0 mm.; p. 1576.

Fig. 4. *Oliva (Omogymna) Martensii* Dall; Chipola Oligocene; alt. 19.5 mm.; p. 1576.

Fig. 5. *Rhynchonella salpinx* Dall, hæmal view; Eocene of Wilmington, North Carolina; lon. 8.2 mm.; p. 1535.

Fig. 6. The same, viewed from in front.

Fig. 7. The same, viewed from the side; *a*, the line of junction of the deltidial plate with the valve.

Fig. 8. *Argyrotheca Schucherti* Dall; Miocene of Jackson Bluff, Florida; lat. 5.8 mm.; p. 1539.

Fig. 9. *Ringicula chipolana* Dall, Proc. U. S. Nat. Mus., xviii., 1895, p. 25; Chipola Oligocene of Florida.

Fig. 10. *Rhynchonella Holmesii* Dall, anterior view; Eocene of Wilmington, North Carolina; p. 1536.

Fig. 11. The same, hæmal valve of adult; lat. 10.0 mm.

Fig. 12. The same, young, the beak slightly defective; alt. 7.0 mm.

Fig. 13. *Discinisca lugubris* Conrad, basal valve; seen from above, the posterior portion partly defective; Miocene of Virginia; lat. 13.5 mm.; p. 1534.

Figs. 14–20. *Terebratula wilmingtonensis* Lyell and Sowerby; 14, young shell, smooth, alt. 27.0 mm.; 15, next stage, showing inception of crenulations, alt. 29.0 mm.; 16, basal view of 17; 17, full-grown specimen with strong crenations, alt. 36.0 mm.; from the ventral valve of a specimen of this sort Ravenel probably described his *T. canipes;* 18, adult specimen with hardly any crenation, alt. 35.0 mm.; 19, very narrow specimen, alt. 36.0 mm.; 20, large adult of unusual breadth and only faint indications of a tendency to crenulate, alt. 40.0 mm.; all from Eocene limestone of Wilmington, North Carolina; p. 1537.

PLATE LIX.

Fig. 1. *Actæon myakkanus* Dall; Pliocene marl of Myakka River, Florida; alt. 8.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 24, 1895.

Fig. 2. *Terebra chipolana* Dall; Chipola Oligocene; alt. 12.0 mm.; *op. cit.*, p. 39, 1895.

Fig. 3. *Actæon fusulus* Dall; Chipola Oligocene; alt. 7.5 mm.; *op. cit.*, p. 23, 1895.

Fig. 4. *Atys obscurata* Dall; Chipola Oligocene; alt. 4.0 mm.; *op. cit.*, p. 30, 1895.

Fig. 5. Posterior and anterior plates of *Chiton Burnsii* Dall; from Pliocene marl of Shell Creek, Florida; lat. of posterior valve 8.5, of anterior valve 7.7 mm.

Fig. 6. The same.

Fig. 7. *Terebra* (*Oxymeris*) *dislocata* Say var. *indenta* Dall; Miocene of Duplin County, North Carolina; alt. 28.0 mm.; Proc. U. S. N. Mus., xviii., p. 40, 1895.

Fig. 8. *Tornatina incisula* Dall; Chipola Oligocene; alt. 5.5 mm.; *op. cit.*, p. 25, 1895.

Fig. 9. *Retusa chipolana* Dall; Chipola Oligocene; alt. 5.5 mm.; *op. cit.*, p. 28, 1895.

Fig. 10. *Scaphander Langdoni* Dall; Chipola Oligocene; alt. 13.0 mm.; *op. cit.*, p. 28, 1895.

Fig. 11. *Actæon chipolanus* Dall; Chipola Oligocene; alt. 6.3 mm.; *op. cit.*, p. 23, 1895.

Fig. 12. *Cylichnella Gabbi* Dall; Pliocene marl of the Caloosahatchie, Florida; alt. 4.75 mm.; *op. cit.*, p. 27, 1895.

Fig. 13. *Terebra* (*Oxymeris*) *bipartita* Sowerby var. *spirifera* Dall; Oligocene of St. Domingo; alt. 30.0 mm.; *op. cit.*, p. 38, 1895.

Fig. 14. *Atys* (*Acrostemma*) *salina* Dall; Eocene of Louisiana; alt. 4.5 mm.; *op. cit.*, p. 29, 1895.

Fig. 15. *Atys* (*Acrostemma*) *gracilis* Dall; Chipola Oligocene; alt. 5.0 mm.; *op. cit.*, p. 29, 1895.

Fig. 16. *Haminea pompholyx* Dall; Chipola Oligocene; alt. 6.5 mm.; *op. cit.*, p. 32, 1895.

Fig. 17. *Retusa* (*Cylichnina*) *quercinensis* Dall; Oak Grove sands; alt. 2.5 mm.; *op. cit.*, p. 31, 1895.

Fig. 18. *Tornatina myrmecoön* Dall; Miocene of Duplin County, North Carolina; alt. 6.0 mm.; *op. cit.*, p. 25, 1895.

Fig. 19. *Terebra* (*Oxymeris*) *omitra* Dall; Oligocene of St. Domingo; alt. 9.5 mm.; *op. cit.*, p. 39, 1895.

Fig. 20. *Retusa* (*Cylichnina*) *decapitata* Dall; Chipola Oligocene; alt. 5.25 mm.; *op. cit.*, p. 30, 1895.

Fig. 21. *Retusa* (*Cylichnina*) *duplinensis* Dall; Miocene of Duplin County, North Carolina; alt. 6.75 mm.; *op. cit.*, p. 31, 1895.

Fig. 22. *Tornatina persimilis* Dall; Chipola Oligocene; alt. 3.0 mm.; *op. cit.*, p. 26, 1895.

Fig. 23. *Micromelo* (*Abderospira*) *chipolana* Dall; Chipola Oligocene; alt. 4.5 mm.; *op. cit.*, p. 32, 1895.

Fig. 24. *Atys œdemata* Dall; Chipola Oligocene; alt. 4.5 mm.; *op. cit.*, p. 28, 1895.

Fig. 25. *Retusa* (*Cylichnina*) *microtrema* Dall; Miocene of Duplin County, North Carolina; alt. 3.2 mm.; *op. cit.*, p. 31, 1895.

Fig. 26. *Turritella alcida* Dall; uppermost Oligocene of Oak Grove, Florida; alt. 8.5 mm.; *op. cit.*, p. 23, 1895.

Fig. 27. *Terebra* (*Oxymeris*) *Langdoni* Dall; Chipola Oligocene; alt. 20.0 mm.; *op. cit.*, p. 39, 1895.

Fig. 28. *Terebra* (*Oxymeris*) *bipartita* Sowerby var. *cirrus* Dall; Oligocene of St. Domingo; alt. 25.0 mm.; *op. cit.*, p. 38, 1895.

Fig. 29. *Terebra* (*Oxymeris*) *bipartita* Sowerby var. *oligomitra* Dall; Oligocene of St. Domingo; alt. 38.0 mm.; *op. cit.*, p. 38, 1895.

Fig. 30. *Terebra* (*Hastula*) *haitensis* Dall; Oligocene of St. Domingo; alt. 62.0 mm.; *op. cit.*, p. 35, 1895.

Fig. 31. *Terebra Gabbi* Dall, adolescent specimen, showing nepionic sculpture gradually becoming obsolete with the increasing rotundity of the whorls; Oligocene of St. Domingo; alt. 70.0 mm.; *op. cit.*, p. 34, 1895. This is *T. robusta* Gabb, 1873, not of Hinds, 1843.

PLATE LIX.

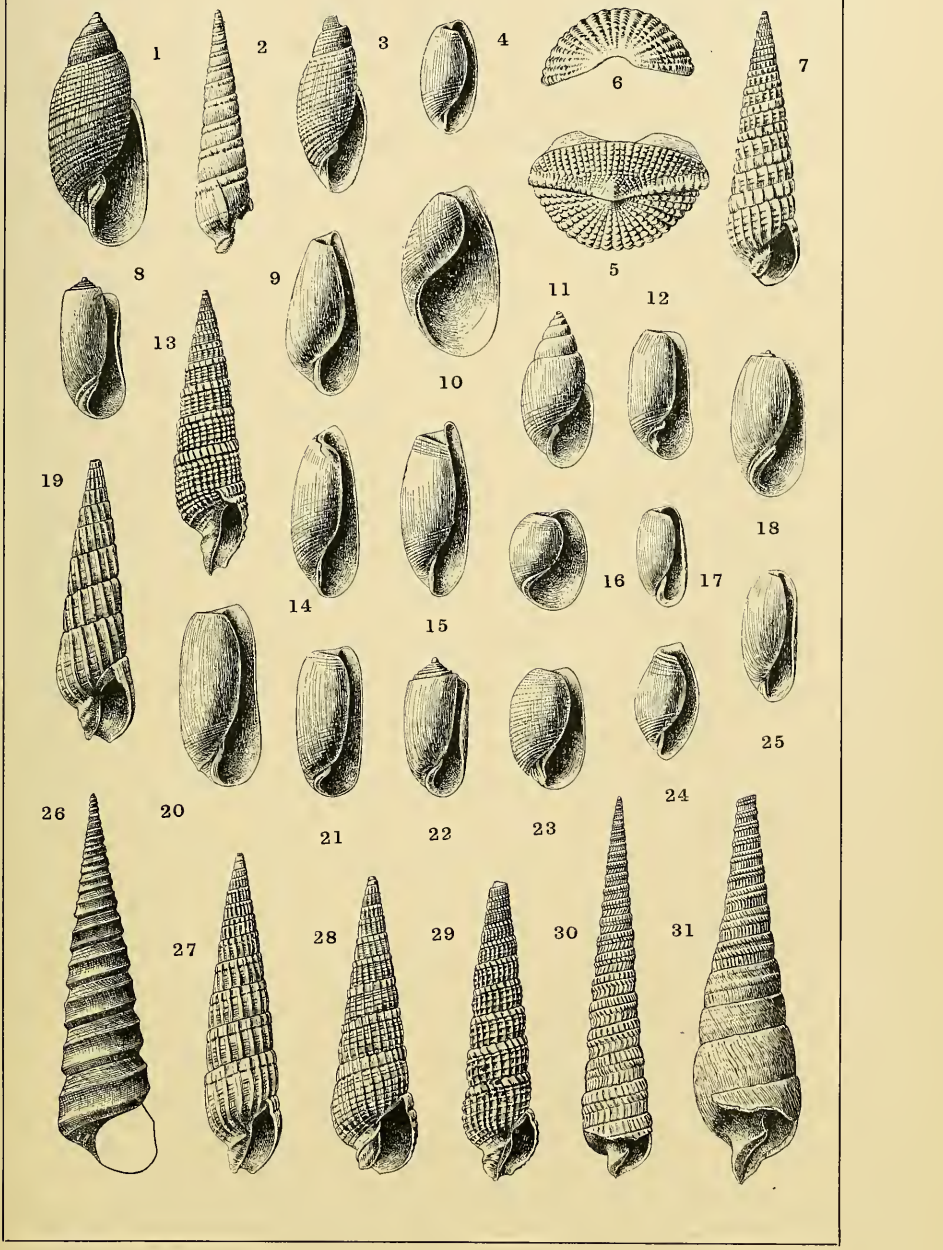
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PLATE LX.

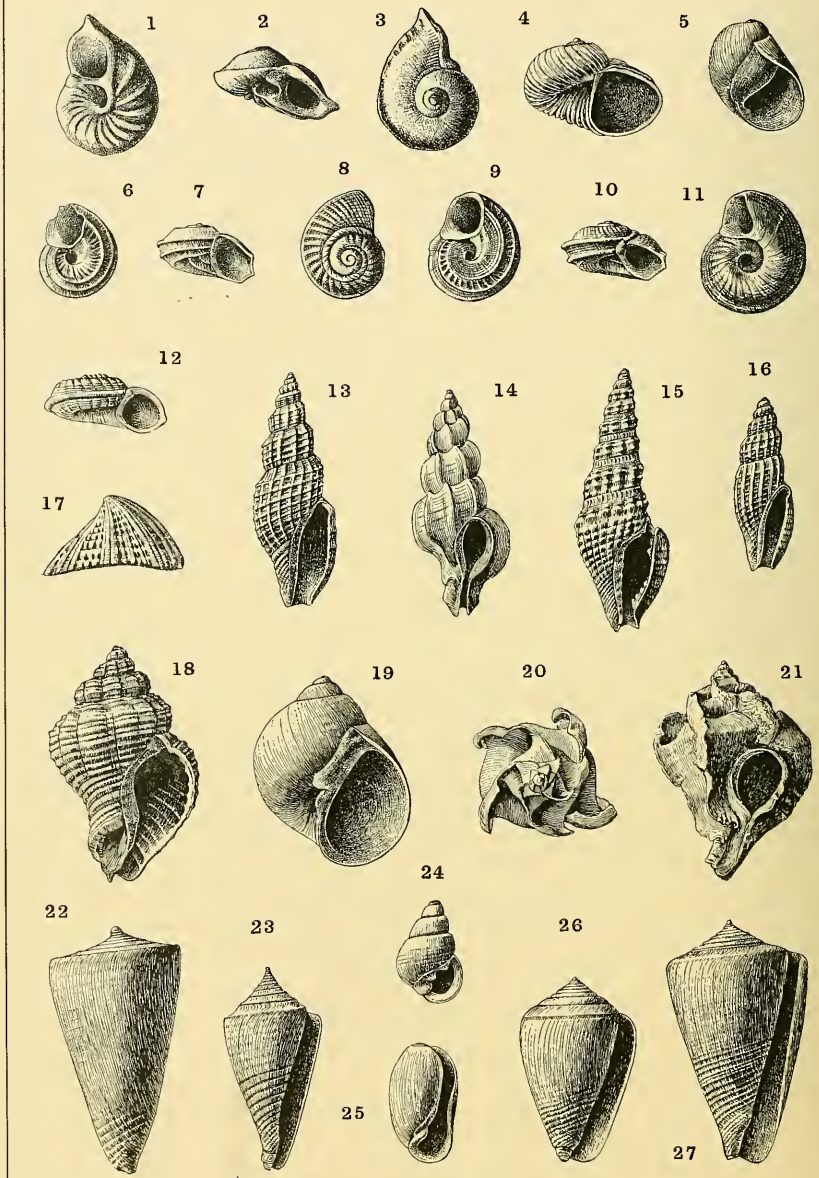

PLATE LX.

Fig. 1. *Teinostoma* (*Climacia*) *calliglyptum* Dall, basal view; Pliocene marl of Shell Creek, Florida; diam. 3.0 mm.

Fig. 2. The same, in profile.

Fig. 3. The same, from above.

Fig. 4. *Macramphalina* (*Gyradisca*) *duplinensis* Dall; Miocene of Duplin County, North Carolina; diam. 3.6 mm.; Proc. U. S. Nat. Mus., xviii., p. 45, 1895.

Fig. 5. *Neritina* (*Smaragdia*) *merida* Dall; Pliocene marl of Shell Creek, Florida; alt. 4.5 mm.

Fig. 6. *Umbonium* (*Solariorbis*) *floridanum* Dall, basal view; Pliocene marl of the Caloosahatchie, Florida; diam. 1.6 mm.; Proc. U. S. Nat. Mus., xviii., p. 45, 1895.

Fig. 7. The same, in profile.

Fig. 8. *Umbonium* (*Solariorbis*) *duplinense* Dall, from above; Miocene of Duplin County, North Carolina; diam. 2.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 46, 1895.

Fig. 9. The same, basal view.

Fig. 10. The same, in profile.

Fig. 11. *Umbonium* (*Solariorbis*) *undula* Dall, basal view; Miocene of Duplin County, North Carolina; diam. 2.5 mm.; Proc. U. S. Nat. Mus., xviii., p. 46, 1895.

Fig. 12. The same, in profile.

Fig. 13. *Cythara metria* Dall; Pliocene marl of Shell Creek, Florida; alt. 7.5 mm.

Fig. 14. *Aspella senex* Dall; Pliocene marl of Shell Creek, Florida; alt. 9.5 mm.

Fig. 15. *Glyphostoma scaptes* Dall; Pliocene marl of Shell Creek, Florida; alt. 12.5 mm.

Fig. 16. *Cythara micrameris* Dall; Pliocene marl of Shell Creek, Florida; alt. 5.2 mm.

Fig. 17. *Subemarginula retiporosa* Dall, in profile; Pliocene marl of Shell Creek, Florida; lon. 13.0 mm.; see also Plate LV., Fig. 3.

Fig. 18. *Solenosteira Vaughani* Dall; Miocene of Coe's Mill Run, Florida; alt. 32.0 mm.

Fig. 19. *Neverita caënsis* Dall; Miocene of Coe's Mill Run, Florida; alt. 34.0 mm.

Fig. 20. *Pterorhytis* (*Conradiana* Dall, var.?) *fluviana* Dall, apical view, showing varices; Pliocene of Shell Creek, Florida.

Fig. 21. The same, front view; alt. 34.0 mm.

Fig. 22. *Canus demiurgus* Dall, young shell; Chipola Oligocene; alt. 38.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 43, 1895.

Fig. 23. *Canus chipolanus* Dall; Chipola Oligocene; alt. 32.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 42, 1895.

Fig. 24. *Ringicula semilimata* Dall; Chipola Oligocene; alt. 2.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 24, 1895.

Fig. 25. *Tornatina Fischeri* Dall; Chipola Oligocene; alt. 2.5 mm.; Proc. U. S. Nat. Mus., xviii., p. 26, 1895.

Fig. 26. *Canus isamitratus* Dall; Chipola Oligocene; alt. 28.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 43, 1895.

Fig. 27. *Canus sulculus* Dall; Chipola Oligocene; alt. 38.0 mm.; Proc. U. S. Nat. Mus., xviii., p. 43, 1895.

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percrassa 1311.
permagna 1316, 1317, 1318.
Philippi 1232.
pinguis 1318, 1319, 1322.
plana 1225.
plena 1309.
plicata 1221, 1273, 1274, 1286.
præopaca 1315.
præparca 1315.
præparea 1315.
puerpera 1220, 1222, 1223, 1271, 1272.
pulcherrima 1248.
pullastra 1322, 1325.
punctata 1344.
pygmæa 1299.
quadrangularis 1319, 1321.
quadrata 1317.
radiata 1314.
reclusa 1454.
reticulata 1220, 1223, 1271, 1392.
rhysomia 1240, 1334.
Rileyi 1309, 1310, *1311*.
rimularis 1318, 1319, 1320.
rostrata 1221, 1222.
rotundata 1323.
rubescens 1269.
rubra 1269.
rugatina 1277.
rugifera 1220.
rugosa 1220, 1271, 1272, 1288.
Sayana 1262.
scalarina 1318, 1319, 1320.
scripta 1220, 1222, 1250.
sinensis 1234
sinuata 1220.
sinuosa 1339.
spinifera 1342, 1356.
staminea 1271, 1279.
striata 1221.
striatula 1286.
Venus, *cont'd.*
submortoni 1316, 1317.
subnasuta 1264.
subrugosa 1302.
subviridis 1454.
tantilla 1240, 1334.
tarquinia 1274.
tenuilamellata 1315, 1318,
tetrica 1316, 1317, 1318.
texana 1317.
texta 1318, 1321.
textile 1322, 1324.
thaca 1326.
tiara 1271, 1286.
tigerina 1341, 1347.
tigrina 1220, 1344.
trapezoidalis 1299.
tridacnoides *1310*, 1311.
tripla 1221.
tumens 1221, 1222, 1223, 1264, 1265.
ulocyma 1296.
undata 1283.
undulata 1322.
undulosa 1286, 1287, 1289, 1319.
varicosa 1298.
verrucosa 1220, 1223, 1227, 1251, 1271, 1272.
vetula 1323.
virginea 1318, 1319.
virginica 1475.
Walli 1291.
Woodwardi 1291.
Venusarius 1221, 1271, 1272.
Verticordia *1509*, 1510, 1511, 1512.
bowdenensis 1512.
cælata 1513.
Cossmanni 1512.
Dalliana 1510.
Emmonsi *1512*, 1513.
eocenense 1510.
eocenensis *1510*, 1511, 1512.
eocensis 1510, 1512.
Fischeriana 1509.
jamaicensis 1511.
mississippiensis *1510*, 1511.
novemcostata 1513.
ornata 1512, 1513.
quadrangularis 1511.

Verticordia, *cont'd.*
sotoënsis 1510.
Verticordiidæ 1509.
Vetericardia 1410.
Vetocardia 1410.
Villarita 1451.
Villorita 1440, *1451.*
Villorita, *cont'd.*
cyprinoides 1452.
floridana 1452.
Volupia 1288.
rugosa 1288.
Vulcanomya 1504.
Smithii 1504.
Waldheimia
Kennedyi 1540.
Woodia 1485, 1487.
Xenophora
humilis 1400.
Zucleica 1286.

ADDENDA AND ERRATA.

Part I., page 84: *Volutilithes precursor,* having a specific name already in use, was renamed *V. whcclockensis* by Cossmann in 1899.

Part I., page 107: Under *Latirus rugatus* omit Fig. 6, which represents *Fusus nexilis* Dall, page 127.

Part I., page 109, line 8: According to present usage the name *Busycon* will take precedence of *Fulgur.*

Part I., page 109, line 12: For "1847" read "1867."

Part I., page 128: Under *Fusus nexilis,* for "Fig. 4" read "Fig. 6."

Part I., page 186: Following Fig. 4 read "*Fusus ballista* Dall; 26.0 mm.; page 127," and transfer the line following Fig. 4 to follow Fig. 6, erasing the line now printed after Fig. 6.

Part II., page 246: *Pyramidellidæ.* A complete revision, with many additions to the species of this family, is nearly ready for the printer.

Part II., page 248: *Odontostomia* Jeffreys. After much correspondence and a great deal of trouble it has been discovered that a single marine species of this genus was contained in Fleming's original list of Odostomias, and therefore, on the principle of elimination, the name may be retained as he wrote it for the marine forms.

Part II., page 276, lines 4 and 22: For "*Styliferina*" read "*Alabina.*"

Part II., page 290, line 14: For "1789" read "1784;" add "not of Gmelin, Syst. Nat., vi., 3131, 1792."

Part II., page 311, lines 19 and 38: For "Yorktown, Virginia," read "Greenboro', Maryland."

Part II., page 326: According to Harris *Solarium texanum* Gabb, the type specimen, is an individual of *S. scrobiculatum* Conrad. He therefore renames the species called *S. texanum* on line 19, which takes the name of *S. sylværupis* Harris, 1896.

Part II., page 331, bottom line: *Omalaxis Singleyi* Aldrich has been described from the Eocene of Lee County, Texas, in 1892.

Part II., page 348: For "*Mitularia* Schumacher," read "*Cheilea* Modeer, 1793."

Part II., pages 374, 377: For "Jacksonian Eocene . . . of Claiborne, Alabama," read "Oligocene of Jacksonboro', Georgia."

Part II., page 387: *Collonia radiata.* This immature shell is probably a young *Teinostoma* of the section *Climacia.*

Part II., pages 399, 402: *Eutrochus* and *Leiotrochus.* As the former name has been found to apply to a very distinct group, the name *Leiotrochus* must probably be adopted for the umbilicate Calliostomas; page 402, for "*distans Conrad,*" read "*conus* H. C. Lea, 1845."

Part II., page 432: The discussion here of *Creseis* and *Styliola* appears to be incom-

plete, and the conclusion the exact reverse of what it should have been. See "Report on the Mollusca of Porto Rico," page 360.

Part III., page 526, line 7: In another specimen of *Dimya* furnished by me to Dr. Ridewood for dissection the inner direct filaments were present, so that the specimen in which they did not occur must have been abnormal. In some of the abyssal Amusium, like *A. Dalli,* I found the filaments not reflected, and this was apparently the case; yet in others they are folded back; and the truth seems to be that, while they are normally and technically reflected, the filaments are easily smoothed out so as to show hardly any trace of angulation, and this fortuitously occurs in a certain number of the dredged individuals, nearly all of which are more or less broken.

Part IV., page 584, line 8: For "*Glomus* Jeffreys" (preoccupied name) read "*Pristigloma* Dall, 1900."

Part IV., page 608: Add to the enumerated species of the fourth paragraph, "*Axinea bella* Conrad, from the Day's Point, Virginia, Miocene; Am. Journ. Conch., vi., p. 199, pl. xiii., fig. 1, 1871."

Part IV., page 647: After last line read "Oligocene of Panama."

Part IV., page 695, line 23: Add "cf. *Auricularia* Blainville, 1816."

Part IV., page 812: To the synonymy of *Teredo* add "*Cyphus* Sacco, 1901."

Part IV., page 833: To the synonymy of *Saxicava* add "*Haicana* Sacco, 1901, not of Mayer."

Part IV., page 835, line 20: Add "but occurs living in Porto Rico."

Part IV., page 836: After line 14 insert "*Matonia* Larranaga, 1821."

Part IV., page 858, line 26: After "1845" insert "Probably = *Tugoniopsis* sp., from type."

Part IV., page 861: After line 6 add "*Tugoniopsis reflexa* H. C. Lea (as *Mya*), 1845, from the Miocene of Petersburg, Virginia."

Part IV., page 879, line 10: Add "*Pseudoxyperas* Sacco, 1901, type *Mactra aspersa* Mayer non Sowerby."

Part IV., page 883, line 13: Add "= *Mactra lutraria* L."

Part V., page 950: Add to the synonymy of *Solecurtus* Blainville, 1824, "*Pharus* Sacco, 1901."

Part V., page 960: Add to the synonymy of *Azor* Leach, "*Azorinus* Recluz, 1870."

Part V., page 975, line 20: Add "= *Macropsamma* Cossmann, 1902."

Part V., page 985: To the synonymy of *Semele* add "*Syndesmyella* Sacco, 1901," *S. profunda* Conrad is an example.

Part V., page 1045: Under *Psammacoma* Dall add, as a synonym, "*Macomopsis* Sacco, 1901."

Part V., page 1066, line 4: For "*Callocardia*" read "*Vesicomya.*"

FINAL NOTE.

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